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KURIR (A.). **Wichtige forstschädliche Insekten.** [Important Insects injurious to Forests.]—*Frommes Forstkal.* **75** repr. 39 pp. Vienna, 1947.

This small handbook is designed to assist the rapid identification of insects injurious in forests in Austria. The forests and woodlands are divided into six types, and lists are given of the insects that are liable to occur in each, arranged under the tree concerned and the type of injury caused. The effects of the damage and appropriate control measures are very briefly indicated in many cases.

NANNIZZI (A.). **I parassiti delle piante officinali. Repertorio dei parassiti vegetali ed animali che danneggiano le piante officinali, aromatiche e da profumo, spontanee e coltivate, e le droghe officinali immagazzinate.** [The Parasites of Medicinal Plants. A Register of the Animal and Plant Parasites injurious to wild or cultivated Medicinal and Aromatic Plants, Plants used in Perfumery and Stored Drugs.]—xxvii+544 pp., 3½ pp. refs. Rome, Minist. Agric. For., 1941.

The first two sections of this work deal with wild and cultivated plants of pharmaceutical importance in Italy, and the third with stored herbs and similar vegetable products. The plants are arranged alphabetically under their popular names and the stored herbs, etc., under their Latin designations. The information given on each includes notes on the animal pests and plant parasites known to attack it in Italy. Most of the animal pests are insects, and brief accounts of their appearance, bionomics, distribution and control and of the injury they cause are included in most cases. An appendix contains information of a similar nature on the pests of a few other miscellaneous pharmaceutical products and notes on the control of certain insect and other pests that are common in laboratories, chemists' shops and places where drugs are stored. Separate indexes are given to the plant parasites, animal pests, and plants attacked, arranged under their scientific names.

FREEMAN (J. A.) & TURTLE (E. E.). **Insect Pests of Food. The Control of Insects in Flour Mills.**—iv+84 pp., 54 figs., many refs. London, Minist. Food, 1947. (From H.M. Stationery Office, price 7*s.* 6*d.*)

The first section of this booklet, which is intended for the use of flour millers in Great Britain, is a brief survey of the monetary losses caused by insect pests of stored products and the ways in which they damage wheat and flour and interfere with milling processes. Measures for preventing insects and mites from entering and multiplying within mill premises and for controlling established infestations are described in the second section, and the third comprises notes on the appearance and bionomics of 16 insects and a mite that are the most important mill pests, with the damage caused by them, and two Hymenopterous parasites; their scientific and popular names and those of 17 other common insect pests are given in a table, which shows in what articles or parts of a mill they are found. The final section contains information on the pests that occur in wheat and flour from different countries, empty sacks, warehouses and different parts of mill buildings and machinery, and includes a brief discussion of the ways in which insects reach the mill.

SCHWERDTFEGER (F.). **Chemische Verfahren der Borkenkäferbekämpfung.** [Chemical Methods in the Control of Bark-beetles.]—*Forst u. Holz* **2** no. 4 pp. 27–30, 8 refs. Hanover, 1947.

This is a discussion of recent work in Germany on the use of insecticides in the control of bark-beetles on spruce. G. Wellenstein, working in East Prussia,

(283) Wt. P3/1804 5/49 S.E.R. Ltd. Gp 432. [A]

claimed to have obtained good results in 1942 by applying dinitro-o-cresol dusts to a narrow strip of ground on both sides of felled infested trunks and to the bark removed from them, which eliminated the necessity of collecting the bark on sheets and burning it to prevent the emergence of beetles, and W. Zwölfer also recommended this procedure in 1946, though he admitted that beetles and the later immature stages within the bark were not all killed. The author, working in the Harz region, showed that the percentage of beetles entirely enclosed within the bark often exceeded 50. If a fairly lasting poison were used, these would be killed on emergence, but sufficiently early emergence is unlikely in winter, so that the bark would eventually have to be destroyed, which would deprive the method of its principal advantage.

The author has since 1946 sought to use insecticides in two ways. In the first, the bark of trap logs is sprayed with a lasting contact insecticide to kill the beetles that attempt to enter it, which renders regular inspection and barking of the logs unnecessary and reduces the number of trap logs required, since these are not actually infested. It appeared, however, that the beetles prefer rough bark and enter mostly beneath the bark scales, where a spray would hardly penetrate. Before conclusive tests could be made, Wellenstein, in south-west Germany, recommended calcium arsenate for the same purpose, but although he appeared to have obtained control with this stomach poison, it proved ineffective in tests by the author in which beetles were allowed to enter or emerge from treated sections of logs. The other method tested was to treat infested logs with a spray that would penetrate the bark and kill the beetles within. Penetration was by way of the entrance holes and also the ventilation holes of the beetles, which were found to be much more numerous than had hitherto been thought. Several proprietary contact poisons were tested in the laboratory and field and some of them gave promising results, but the work was not sufficiently advanced for recommendations to be made.

THALENHORST (W.). **Zur Borkenkäfer-Prognose.** [On the Forecasting of Bark-beetle Abundance.]—*Forst u. Holz* **2** no. 9 pp. 65–67. Hanover, 1947.

Forecasts of abundance of *Ips typographus*, L., in spruce forests in Germany can be made only on the basis of investigations in each individual focus of infestation, and in this paper a practical method of carrying these out and of ascertaining the number of trap logs required for control is described. Since the adults begin to emerge at the end of April and the logs are most attractive about a month after felling, the work should be completed by the end of March. Sample infested trees are selected throughout the area concerned to represent the different conditions in it, and two rings of bark 10 ins. wide are removed from each, one at a height of about 16 ft. above the ground and the other about the same distance below the tip in short trees or 33 ft. below it in tall ones. If the upper ring shows no infestation, the highest infested point is ascertained by ripping down a strip of bark and another ring is taken 16 ft. below this. The young adults exposed in removing the rings are counted and the two rings from each tree are measured, examined for exit-holes and brood galleries and cut up to expose the adults within the bark. The sum of all the adults and exit-holes found gives the total number of adults produced, and since the sex ratio is 1 : 1, half of it represents females. This is divided by the number of brood galleries found in the two rings, which represent the females of the previous generation, parts of galleries being reckoned as one half each, and the figure obtained is termed the reproduction coefficient or coefficient of spread. The product of the average coefficient for all the sample trees and the number of infested trees in the area represents

the number of logs required to trap the emerging population. The accuracy of this figure can be improved by introducing certain corrections. These are required if the infestation on the sample trees is restricted to certain areas of the bark, when the number of trap logs is reduced in proportion, and if the number of brood galleries per unit area is excessively high or low. The maximum average number that permits normal development is 600–700 per sq. metre of bark, though up to 1,000 sometimes occur. The figure taken should not exceed the maximum average, and the number of trap logs can be reduced proportionately if it is much less.

In order to make best use of the trap logs, the ecological requirements of the beetles should be considered. When choosing surfaces for breeding, they prefer a temperature of about 25°C. [77°F.], so that at the end of April they select those exposed to the sun and at the end of May those in the shade. The former should be barked earlier than the latter and the bark burnt to prevent the parent females from leaving it and flying to fresh trunks in June.

SCHIMITSCHEK (E.). **Lebensweise und Lebensverein des** *Scolytus pyri* **var.** *bicallosus* **Eggers.** [The Mode of Life and Associates of *S. pyri* var. *bicallosus*.]—*Allg. forst- u. holzw. Ztg.* **57** pt. 1–2 pp. 9–11, 6 figs., 8 refs. Vienna, 1946.

SCHEDL (K. E.). **Zur Frage des** *Scolytus pyri* **var.** *bicallosus* **Egg.** [Contribution to the Question of *S. pyri* var. *bicallosus*.]—*Op. cit.* **58** pt. 7–8 repr. 2 pp. Vienna, 1947.

In the first of these papers, Schimitschek follows Eggers in considering that *Scolytus pyri*, Ratz., is distinct from *S. mali*, Bechst. (*pruni*, Ratz.) and has a local variety, *bicallosus*, Eggers. He quotes Eggers' description of var. *bicallosus* and gives a key to the adults of all three forms based on Eggers' work. Var. *bicallosus* was originally described from Hungary but also occurs in Austria and Czechoslovakia and has been observed, together with the other two forms, near Vienna since 1941 ; it is considered to be a south-eastern form of *S. pyri*. It chiefly attacks apple trees, but has also been found in plum and apricot. The trees infested are mainly sickly or damaged by frost and in extreme cases are killed by the attack. The brood and larval galleries are described ; the larvae feed in the cambial zone, but enter the sapwood to pupate. A key to the galleries of the three forms is given.

Var. *bicallosus* had only one generation a year near Vienna in 1941 and 1942, the adults being present from 16th June to 8th July and from 19th May to 26th June, respectively. Winter is passed in the pupal chambers. The larvae were parasitised by the Braconid, *Ascogaster instabilis*, Wesm., the adults of which emerged at the beginning of July, and by the Eulophid, *Elachertus* (*Elachistus*) *leucogramma*, Ratz., which occurred frequently and was of economic importance, and the larvae of *Phloeopora teres*, Grav., *Axinotarsus marginalis*, Lap., and *Dasytes aerosus*, Kiesw., were predacious on them.

In the second paper, Schedl points out that Schimitschek's figure of var. *bicallosus* does not agree with Eggers' description and that species of the genus *Scolytus* frequently show morphological variations resulting from particular breeding conditions. He has himself been engaged for some years on a revision of the genus and has examined the types of many of the palaearctic forms, including those of var. *bicallosus*, together with long series of specimens from different localities. He considers that the characters supposed to differentiate *bicallosus* from *pyri* are invalid and that characters ranging from those of typical *mali* to *pyri* are exhibited by different individuals of a long series of the same form, so that *pyri* is at most an extreme variation of *mali*. The fact that *bicallosus* has been reported from frost-injured trees

may indicate that it is merely a hunger form, though it may have resulted from inbreeding. The separation of forms in Scolytids on the basis of differences in the galleries is quite unjustified. The species is redescribed from the adults of both sexes, and a list of its food-plants given.

Ruiz Castro (A.). **Fauna entomológica de la vid en España. Estudio sistemático-biológico de las especies de mayor importancia económica. IV (Coleoptera).** [The Insect Fauna of Grape Vines in Spain. Studies of the Systematics and Bionomics of the Species of major economic Importance. IV (Coleoptera).] —132[+1] pp., 8 pls. (4 col.), 51 figs., 45 refs. Madrid, Inst. esp. Ent., 1947.

In this fourth part of a work on insects that attack grape vines in Spain, which resembles the previous parts in its general arrangement [*cf. R.A.E.*, A **35** 270], detailed accounts are given of the synonymy, distribution, morphology, bionomics, food-plants and economic importance of *Vesperus xatarti*, Duf., *Byctiscus betulae*, L., and *Haltica lythri* var. *ampelophaga*, Guér., which are the only Coleoptera that seriously damage vines there. The last is especially injurious. The author considers it a variety of *H. lythri* and not a distinct species because of the observations of Picard [**16** 240] and Balachowsky [**25** 105]. Notes are included on the natural enemies of the last two. The only one of any importance observed in Spain is *Zicrona coerulea*, L., which is predacious on the larvae of var. *ampelophaga*.

Piédrola Gil (G.). **Recientes adquisiciones y técnicas de empleo del D.D.T.** [Recent Information concerning DDT and its Uses.]—xi+307 pp., 26 pls. (54 figs.), many refs. Madrid, Inst. esp. Med. colon., 1948. Price 100 *ptas.*

This book is based substantially on the sections dealing with DDT in an earlier work by the author [*R.A.E.*, A **36** 60], but the information in them has been considerably amplified and brought up to date. It is divided into chapters dealing with the nature and chemical properties of DDT, its mode of action on insects and the symptoms produced in them, methods of analysis, and the ways in which it is employed against arthropods of medical and veterinary importance and pests of crops and stored products. A short section is included on the impregnation of textiles and paper.

Pests of Citrus Trees and Fruit.—*Leafl. Dep. Agric. Cyprus* no. 24 (revd.), 4 pp. Nicosia, 1946.

This revision of a leaflet already noticed [*R.A.E.*, A **26** 706] contains notes on two additional pests of *Citrus* in Cyprus. *Icerya purchasi*, Mask., is now firmly established in several areas, but is efficiently controlled in all of them by *Rodolia* (*Novius*) [*cardinalis*, Muls.], which was imported against it [*cf.* **28** 454]. A rust mite, provisionally identified as *Phyllocoptruta* (*Phyllocoptes*) *oleivorus*, Ashm., has become a serious pest in the last few years [*cf.* **34** 371]. It can be controlled by spraying with lime-sulphur or oil emulsion, or by dusting with sulphur.

[Peredel'skiĭ (A. A.).] **Передельский (А. А.). Certain Considerations relating to the Dynamics of the Abundance of *Eurygaster integriceps* Put.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* (N.S.) **59** no. 7 pp. 1345–1348, 1 ref. Moscow, 1948.

This discussion of the variations in population that occurred during an outbreak of *Eurygaster integriceps*, Put., on cereals in the Department of Stalingrad is based on an analysis of records for the years 1937–46 and observations in September 1947 in sites of mass hibernation in oak and pine woods

along the River Don. The records showed that for the whole Department the cultivated areas infested and the areas in which the bugs hibernated increased rapidly to a maximum in 1941 and then decreased almost as quickly, but the average density of the population per unit area reached a peak in 1940, though there were local variations in both cases. The outbreak did not begin any earlier in the two districts in which a previous one had begun than in the others, and the first increases were recorded in widely separated localities between 1937 and 1939. There was no evidence of a continuous wave extending over the whole Department either in space or time and the appearance of new foci could not have resulted entirely from continuous expansion from the original ones, though migration must have been involved in the doubling of the infested area in 1941 since the density decreased at the same time. The peak in density in 1940 was reached in spite of a long damp spring and fluctuating temperatures, which protracted the oviposition period and nymphal development and are supposed to be unfavourable. The collapse of the outbreak is attributed to the activity of parasites and predators and possibly disease. Dead bugs observed in September 1941 and probably remaining from the previous two winters had all been parasitised by Phasiine Tachinids [*cf.* **33** 301–302] or attacked by predacious beetles. There was evidently no winter mortality due to abiotic factors in those years, though alternate frosts and thaws had killed many bugs in some localities during the peak of the outbreak.

MITCHELL (B. L.). **Preliminary Observations on the Effect on Tobacco of Soil Applications of Gammexane.**—*Rhod. agric. J.* **43** no. 5 p. 393, 1 ref. Salisbury, S. Rhod., 1946.

In the experiments in Southern Rhodesia in which a dust containing 0·5 per cent. γ benzene hexachloride was applied to the soil of tobacco fields at rates of up to 200 lb. per acre [*R.A.E.*, A **36** 137], the state of the plots at harvest did not permit a comparison of yields, but the treatments did not produce any adverse effect on the growth of the plants or on the quality of the cured and graded leaf.

MITCHELL (B. L.). **Compost and White Grubs in Tobacco Lands.**—*Rhod. agric. J.* **43** no. 5 pp. 408–411 ; also as *Bull. Minist. Agric.* [*S. Rhod.*] no. 1365, 5 pp. Salisbury, S. Rhod., 1946.

An account is given of an experiment carried out in Southern Rhodesia in 1945–46 to ascertain whether the application of compost to the soil in which tobacco is grown causes an increase in infestation and damage by Lamellicorn larvae. Compost made from sunn-hemp [*Crotalaria juncea*] was applied at the rate of 4 tons per acre ; it was either broadcast or applied in the hills, before oviposition began or after it was over. The field was ploughed in late May 1945, the compost applied and the hills made up early (24th October) or late (21st December) and the tobacco planted on 28th December. The plots were sampled for insects from 21st to 26th January 1946, and stand counts were made weekly from the time of planting until the end of January, when insect damage ceased. The larvae recovered comprised *Schizonycha manicana*, Péring., *Adoretus* sp. and three unidentified species of *Anomala*. Statistical analysis of the figures obtained, which are tabulated, showed that the early applications of compost both increased the population of one species of *Anomala* to a highly significant degree. The broadcasting increased it to about five times and the application in hills to about eight times its density in plots to which no compost was applied, and the difference between these two treatments was itself significant. Late treatments had no effect on this species, and none of them had any effect on any of the others individually. When all

five species were considered together, however, plots to which compost was applied early in the hills still contained significantly more larvae than plots with no compost or with compost applied late, though early broadcasting lost its significance. The number of transplants killed was found to be increased by the early treatments to a highly significant extent, but late treatments had no effect. When the two sets of figures were compared, it was evident that the amount of damage done is directly and closely proportional to the number of larvae present, indicating that, in practice, any reduction of the possible total of larvae in a field will be immediately reflected in a better stand of plants. By comparing the loss of stand per acre for each treatment with the total population of larvae, it is calculated that an average of about 1,680 larvae per acre is required to cause each 1 per cent. loss of plants.

It is concluded that the larvae are not transferred to tobacco lands from the compost heap when the compost is applied and that late applications do not cause any increase in the population of any species. The experiment offers no evidence that compost either causes a higher survival of larvae or increases their rate of growth.

CROWDY (S. H.). **Observations on the Pathogenicity of** *Calonectria rigidiuscula* **(Berk. & Br.) Sacc. on** *Theobroma cacao* **L.**—*Ann. appl. Biol.* **34** no. 1 pp. 45–59, 2 pls., 20 refs. London, 1947.

The following is largely based on the author's summary. *Calonectria rigidiuscula* has been found on cacao in the Gold Coast associated with an acute and a chronic form of dieback and infecting cankers caused primarily by another fungus, *Phytophthora palmivora*, and lesions caused by the feeding of the Mirids, *Sahlbergella singularis*, Hagl., and *Distantiella theobroma*, Dist. It has also been cultured from Mirid lesions on cacao and from cacao affected with canker and chronic dieback in Nigeria. The association with the Mirid lesions is of great economic importance, since it appears that damage due to the toxin injected by the Mirids in feeding [*R.A.E.*, A **32** 287; **35** 87] is confined to the medullary rays in the peripheral tissues and is capable of killing only green shoots, and that the severe damage caused to woody stems, in which the xylem and phloem are affected, follows infection of the lesions by *C. rigidiuscula*. Mirid attack alone can normally cause only partial defoliation, and this can occur only during periods of rapid stem growth, but infection of the lesions by *C. rigidiuscula* can cause a state approaching complete defoliation at any time of year, and as a result the tree is weakened sufficiently to allow the spread of dieback, which may originate at any of the defoliated shoots. Acute dieback occurs only in certain districts after exceptional drought and may be considered as primarily the result of environmental conditions. The main importance of chronic dieback is that it prevents the recovery of cacao that has been seriously weakened from other causes. *C. rigidiuscula* has been established in wounded cacao stems of all ages without difficulty. Its spread is slow, but is more rapid in the xylem than in the cortical tissues and is greatest in the unlignified tissues.

BAKER (R. E. D.) & DALE (W. T.). **Notes on a Virus Disease of Cacao.**—*Ann. appl. Biol.* **34** no. 1 pp. 60–65, 1 pl., 6 figs., 4 refs. London, 1947.

The following is based on the authors' summary. A virus disease of cacao discovered in north-western Trinidad towards the end of 1943 and produced by two strains that closely resemble each other [*R.A.E.*, A **35** 88] does not occur in the main cacao-growing areas of eastern, central and southern Trinidad and has not been found in Venezuela, Tobago, Grenada, St. Vincent, St. Lucia or Dominica. The symptoms, which resemble those of the swollen-shoot

disease of West Africa, consist of vein-clearing or mosaic of the leaves and red-mottle of the leaves and pods [*loc. cit.*]. No swellings are formed, but recent observations indicate that the disease may cause both dieback and reduction in yield. Although its rate of spread has varied somewhat, a mean increase of 41 per cent. over the original number of infected trees has been found over a period of ten months. As with swollen-shoot disease, existing diseased areas have increased in size and new outbreaks have occurred at short distances. Both strains were readily transmitted by budding, the incubation period varying from 34 to 136 days, with a mean of about 90 days. No insect vectors have so far been found, but two or more mealybugs, probably including *Pseudococcus citri*, Risso, and *Ferrisia* (*Ferrisiana*) *virgata*, Ckll., and the Aphid, *Toxoptera aurantii*, Boy., occur fairly commonly on cacao in Trinidad, and West African experience indicates that one or more of them may transmit the disease [*cf.* **36** 110]. There is at present little reason to believe that any variety of cacao is immune from it or even a symptomless carrier. The question of eradicating this virus while its distribution remains limited deserves serious consideration.

Ross (D. M.), Stapley (J. H.) & Cockbill (G. F.). **Wireworm Populations in Relation to Crop Production. II. Population Changes in Grassland.**—*Ann. appl. Biol.* **34** no. 1 pp. 66–82, 4 figs., 7 refs. London, 1947.

Cockbill (G. F.), Ross (D. M.) & Stapley (J. H.). **III. Population Changes after Summer Ploughing.**—*T.c.* pp. 83–94, 4 figs., 4 refs.

Stapley (J. H.), Ross (D. M.) & Cockbill (G. F.). **IV. Population Changes during a bare Fallow.**—*T.c.* pp. 95–103, 3 figs., 5 refs.

These papers form part of a series on wireworm populations in relation to crop production in eastern England [*cf. R.A.E.*, A **34** 329], and the following is based on the authors' summaries of them. Six grass fields were sampled once a fortnight from July 1943 to September 1944, and the wireworms of the genus *Agriotes* in the samples were counted by the washing and flotation method [*loc. cit.*]. The counts from 20 standard samples showed high fluctuations, which rendered them practically valueless as estimates of wireworm populations when treated singly. When, however, they were treated as running means of four consecutive samples, by taking the mean of the first, second, third and fourth samplings, that of the second, third, fourth and fifth, and so on, they showed certain seasonal trends, with minimum populations in July and August, rising populations throughout the autumn, maximum populations from January to April, and a sharp decline to the minimum populations again from April to July. On the average, the winter counts were twice as high as the summer ones. The fluctuation was evident in all size groups based on larval length, but was most marked in wireworms that were under 4, 4 and 5 mm. long. Samples taken to depths of 12 and 24 ins. showed that on the average about 75 per cent. of the wireworms were in the 0–6 in. layer and about 90 per cent. in the 0–12 in. layer. These proportions varied considerably with the season. The seasonal changes in populations observed do not correspond with those expected from the life-history of *Agriotes* spp. Possible explanations for this anomaly are discussed, but it cannot be attributed to any defect in the sampling method that could be detected or to any known biological factor.

Six permanent pastures broken up in the summer of 1943 were sampled once a fortnight after ploughing. The graphs of the running means of four consecutive counts showed the chief trends in population. In four of the fields, a slight increase in population was apparent up to December. Only in February and March was a definite decline apparent. In the other two fields, the counts declined by about 30 per cent. during the autumn and winter. A

marked fall in population (from 30 to 70 per cent.) was evident in all the fields only after the first crop (winter wheat, barley or peas) had been harvested. The new population at this time was characterised by an absence of larvae less than 4 mm. long. The results considered alone indicate that after summer ploughing the wireworm population remains unaffected until the following spring and summer during the cropping period. When the results are considered in relation to the grass controls, it appears that a net decline in population occurs during the autumn and winter and that the decline in spring and summer is not more marked than that which normally occurs at this time in grass fields. Unlike the grass fields, however, the reduction is permanent.

Changes in wireworm populations during a bare fallow were studied in 23 fields in 1943 and 1944. In every case, populations were much reduced, sometimes to less than 10 per cent. of the original level. Wireworms of all sizes were affected, but the larvae less than 5 mm. long were practically eliminated from the populations. Evidence is presented that the reduction achieved is greater in fields ploughed in February and March than in fields ploughed in May. As the populations in the grass controls decline during the same period, the entire reduction cannot be attributed to the fallow. The reduction in the bare fallow, however, differs from that in the controls in that it is permanent and continues through the autumn when the counts in the controls are rising. The practical implications of the results are discussed.

HARPER (S. H.), POTTER (C.) & GILLHAM (E. M.). *Annona* **Species as Insecticides.** —*Ann. appl. Biol.* **34** no. 1 pp. 104–112, 2 figs., 15 refs. London, 1947.

The following is based on the authors' summary. By extraction and precipitation from several solvents, the toxic principle present in the seeds and roots of *Annona reticulata* and *A. squamosa* was obtained at high concentration. A preliminary chemical examination of this concentrate is described, leading to the conclusion that its toxicity is due to a glyceride or glycerides of a hydroxylated unsaturated acid or acids of high molecular weight. The extracts were tested for insecticidal properties in a variety of media. When used as a contact insecticide against *Aphis fabae*, Scop., *Macrosiphum* (*Macrosiphoniella*) *sanborni*, Gill., and *Macrosiphum solanifolii*, Ashm., the toxicity of the concentrate was of the same order as that of rotenone, but against *Oryzaephilus surinamensis*, L., its toxicity was considerably less. As a stomach poison, the ether extract was both toxic and repellent to larvae of *Plutella maculipennis*, Curt., but was not toxic or repellent to those of *Diataraxia* (*Polia*) *oleracea*, L. Ovicidal tests against the eggs of *P. maculipennis* and *Ephestia kuehniella*, Zell., were inconclusive. The potency of this concentrate is therefore of a limited nature and although of roughly the same order as that of rotenone to certain Aphids, it has neither the intensity of effect nor the range of insecticidal action of that compound.

TREHAN (K. N.). **Distribution of White-Fly in the Punjab.**—*Indian Fmg* **5** no. 11 pp. 514–515, 1 map. Delhi, 1944.

An extensive survey was carried out in 1934–35, to determine the distribution and relative incidence of *Bemisia tabaci*, Gennadius (*gossypiperda*, Misra & Lamba) on cotton or, where this was not available, on other plants under different climatic conditions in the Punjab. The data obtained in 13 localities, comprising the average infestation per sq. in. leaf surface, the average maximum and minimum temperature, the average relative humidity, and the total rainfall, are given in a table. High temperatures and low rainfall were found to favour

rapid multiplication. In addition, infestation was highest at low altitudes and on crops that received little irrigation [*cf. R.A.E.*, A **33** 392].

Cheu (S. P.). **Studies on the planting Date of Corn in Relation to European Corn Borer Infestation.** [*In Chinese.*]—*Kwangsi Agric.* **1** no. 6 pp. 373–383, 9 refs. Liuchow, 1940. (With a Summary in English.) **Correlation of Corn Borer Damage with Growth Condition of Corn and its Significance on Corn Breeding Work.** [*In Chinese.*]—*Op. cit.* **2** no. 1–2 pp. 126–133, 8 refs. 1941. (With a Summary in English.) **The European Corn Borer in Kwangsi.** [*In Chinese.*]—*T.c.* no. 3 pp. 205–222, 5 figs., 24 refs. (With a Summary in English.)

In these papers, the author describes investigations on *Pyrausta nubilalis*, Hb., on maize, carried out near Liuchow, Kwangsi, in 1938–40.

In the first, it is reported that significant differences in degree of infestation were found on plants sown at intervals of two weeks from March to August. Maize sown in May was the most heavily infested. That sown earlier received fewer egg-masses, owing to the scarcity of moths, whereas that sown later received as many egg-masses, but had fewer larvae, possibly because of parasitism of the eggs by *Trichogramma* sp. in July and August or because of the hot, dry weather in autumn, which is unfavourable for the hatching and establishment of the larvae. Since the great fluctuations in rainfall in summer and the hot, dry weather usually prevalent in autumn tend to reduce the yield of maize planted after May, it is concluded that the most suitable time for sowing is in March or April and that the earlier it is carried out within this period, the lower will be the percentage of injured ears.

In the second paper, the author records that egg-masses were not found on plants less than about 20 inches high. The plants took 90–100 days to mature and were attractive to females of *P. nubilalis* for 45–54 of these. Their attractiveness was greatest from three days before tasselling to a week after silking (15–20 days), during which period 67·2–88·6 per cent. of all the eggs were found. Significant positive correlations were found between height of plant and egg or larval population, between diameter of stem and egg or larval population, between height of plant and diameter of stem, and between egg and larval populations.

The third paper deals with the bionomics and control of *P. nubilalis*, which is known to occur in the provinces of Heilungkiang, Liaoning, Kirin, Hopeh, Shangtung, Kiangsu, Chekiang, Hunan, Kweichow, Kwangsi, Yunnan and Szechuan. Maize is its preferred food-plant in Kwangsi; 80–100 per cent. of the plants sown in May are usually infested, the numbers of borers per 100 plants sometimes reaching nearly 3,000. Populations of 100 borers per 100 plants are not uncommon on plantings made before and after May. The moth was found to have six generations a year in Kwangsi. The overwintering larvae entered hibernation in late October and most of them pupated in the second half of the following April, though the first adults emerged in the middle of March. Since it was found that the larva does not move downward in the stubble during hibernation in Kwangsi, the date of cutting the stubble can have little significance in control. The eggs were parasitised by *Trichogramma* sp., and the pupae by *Xanthopimpla stemmator*, Thnb., and *Brachymeria* sp., but only the first was of economic importance. Parasitism by it reached 70–95 per cent. in the autumn of 1938, and averaged 56·6 per cent. during July and August 1939. Cutting the maize stems near the ground and destroying all parts of infested plants by burning or feeding them to livestock before the emergence of the moth is recommended for control. Clean ploughing cannot be practised in the present state of farming in Kwangsi, but early planting, the rotation of crops, improved methods of farming and the breeding of resistant varieties of maize would materially reduce losses.

Lew (T. W.) & Cheu (S. P.). **Some Investigations on the Hibernation and Winter Control of the Pine Caterpillar in Kwangsi.** [*In Chinese.*]—*Kwangsi Agric.* **2** no. 1 pp. 2–13, 4 refs. Liuchow, 1940. (With a Summary in English.)

The overwintering habits of the pine caterpillar, *Dendrolimus punctatus*, Wlk., in different parts of China vary with climatic conditions. In the region extending from southern Kiangsu to the middle of Chekiang, most of the larvae remain quiescent in crevices under loose bark throughout the winter; in southern Chekiang and Kwangsi they overwinter among the pine needles and feed during warm days; and in Kwangtung there is practically no hibernation. At Liuchow, Kwangsi, where there are three generations in the year, 85 per cent. of the larvae overwintered among the needles, and the number of needles damaged and the quantity of frass excreted daily were significantly correlated with the mean daily temperature and the duration of sunshine. The larvae stopped feeding when the mean daily temperature fell below 6°C. [42·8°F.], but since meteorological data for five years in Liuchow, showed that the average number of days in the year with such low temperatures was only seven, winter activity is not seriously checked by climate in this region. They fed as usual on warm rainy days. The remaining larvae overwintered in bark crevices. They left the crevices during warm bright days, but most of them hid under the bark again after sunset. The numbers of overwintering larvae leaving the bark crevices were found to be very significantly correlated with the mean daily temperature and duration of sunshine. Sunlight seemed to be more important than temperature in stimulating movement, as the larvae remained quiescent during rainy or cloudy days when the mean temperature was as high as 15°C. [59°F.] but were observed crawling on the bark on bright days with a mean temperature of only 5°C. [41° F.].

It is concluded that winter control by means of straw traps, removing the bark or applying adhesives, as practised in Nanking [*cf. R.A.E.*, A **27** 449], is impracticable in Liuchow and regions in which the larvae have similar overwintering habits.

Cheu (Seh-pong) & Li (Shon-sing). **Laboratory Experiments on the Control of Sugarcane Woolly Aphis (*Oregma lanigera* Zehntner) with Yam Bean Seed Oil Emulsion and Tobacco Leaf Extract.** [*In Chinese.*]—*Kwangsi Agric.* **3** no. 3 pp. 179–189, 6 refs. Liuchow, 1942. (With a Summary in English.)

Laboratory tests of sprays for the control of *Oregma lanigera*, Zehnt., on sugar-cane in Kwangsi were carried out in 1941. Sprays containing 1 per cent. camphor oil or tea-seed oil emulsified with sodium oleate were ineffective, but emulsions of the oil from the seeds of yam bean [*Pachyrhizus erosus*] showed some promise. Practically all the Aphids with thin wax coatings were killed by a spray containing 1 per cent. of a sample of this oil with a G-S value (percentage content of rotenone or deguelin estimated by the Gross-Smith method) of 0·2 [*cf. R.A.E.*, A **30** 419; **31** 502], and similar results were obtained with sprays containing 0·5 and 0·75 per cent. of samples having G-S values of 0·5 and 0·3, respectively, but only about 10 per cent. mortality of Aphids with a thick coating of wax was given by 1 per cent. oil with a G-S value of 0·51.

Free nicotine (95 per cent.), in sprays containing 0·3 per cent. sodium oleate as a wetting agent, was effective against Aphids with thin and thick wax coatings at concentrations of 1 : 8,000 and 1 : 4,000, respectively. The effectiveness of nicotine, particularly at lower concentrations, was significantly correlated with the amount of sodium oleate in the spray, although sodium oleate at

spray strengths (0·1–0·5 per cent.) was itself not toxic to the Aphid. The addition of 0·5 per cent. camphor oil, tea-seed oil or kerosene to nicotine (1 : 8,000) did not enhance its toxicity.

Tobacco-leaf extract (2·35 per cent. nicotine) killed 84·5–97 per cent. of the Aphids with thick wax coatings at concentrations of 1 : 40–1 : 200 with 0·5 per cent. sodium oleate as wetting agent. Alkaline wetting agents such as sodium oleate or soap, and alkali, such as sodium carbonate, greatly improved its action, but preparations of soap nut (*Sapindus mukurossi*) and soap pod (*Gleditsia sinensis*), which are not alkaline in reaction, had little value. Much of the soap was wasted since it reacted with the mineral salts in the extract to form insoluble compounds, so that the extract was not significantly more effective with soap than with alkali. The function of soap seemed to be to supply alkalinity rather than to improve the wetting power of the spray, and it is therefore more economical to use an alkali.

CHEU (Seh-pong). **Comparative Toxicity of some Vegetable Oil Soaps to Sugarcane Woolly Aphis.** [*In Chinese.*]—*Kwangsi Agric.* **5** no. 1–6 pp. 22–31, 13 refs. Liuchow, 1945.

In preliminary tests with various insecticides against *Oregma lanigera*, Zehnt., on sugar-cane made in Liuchow in 1942-43, a solution of tea-seed oil soap gave promising results, and in 1944 soaps made from eight vegetable oils common in China were tested. All the oils were first saponified with sodium hydroxide, and the fatty acids were prepared by adding a solution of sulphuric acid. For testing, a definite amount of fatty acid was weighed out and the necessary sodium or potassium hydroxide added by titration. In tests of the sodium soaps, in which sodium oleate, two kinds of laundry soap, tallow soap and resin soap were also included, the soap of tea-seed oil was the most toxic to *O. lanigera*, followed in order of decreasing toxicity by those of sesame and soy-bean oils, sodium oleate, laundry soaps, soaps of rape, groundnut, cotton-seed, castor and tung oils, and tallow soap. Resin soap was not toxic. A 0·5 per cent. solution of tea-seed oil soap gave 94–100 per cent. mortality of *O. lanigera* when applied at intervals from June to October.

The insecticidal efficiency of the soap solutions was inversely related to the speed of evaporation, the kill increasing with the length of time that the solution remained moist on the insects, so that sprays should not be applied in extremely hot and dry weather.

The sodium soaps of tea-seed, soy-bean, sesame and rape oils were more toxic than the respective potassium soaps, and sodium oleate was more effective than potassium oleate, but the potassium soaps of cottonseed oil and groundnut oil were more toxic than the sodium soaps.

It is pointed out that soaps that are rich in oleic acid and linoleic acid, such as those of tea-seed, sesame and soy-bean oils, are the most toxic. Cottonseed oil and groundnut oil contain larger proportions of these fatty acids, but they also contain a considerable amount of solid fatty acids, the presence of which lowers the solubility of the resulting soaps, and makes them less effective. In these cases, however, efficiency can be increased by using the more soluble potassium soaps instead of sodium soaps. Soaps made of vegetable oils rich in erucic acid (rape oil), ricinoleic acid (castor oil) and olestearic acid (tung oil) were comparatively less toxic. Laundry soaps were also relatively less toxic as they contain a great amount of solid fatty acids, such as stearic acid in tallow, and only a small quantity of liquid fatty acids, such as oleic acid in liquid vegetable oil, but they were more effective than soaps prepared from pure tallow.

When the soaps were used as spreaders for sprays containing other insecticides, their order of effectiveness was the same as when they were used alone.

CHEU (Seh-pong). **Studies on the Soybean Pests of Kwangsi. I. The Lima Bean Pod Borer (*Etiella zinckenella* Treitschke).** [*In Chinese.*]—*Kwangsi Agric.* **3** no. 6 pp. 351–370, 1 fig., 34 refs. Liuchow, 1943. (With a Summary in English.)

The results are given of observations on *Etiella zinckenella*, Treitschke, as a pest of soy beans in Kwangsi; most of them were made in Shatang, Liuchow, in 1940–42. The Pyralid was common in several localities in Kwangsi, infesting the pods of soy beans, garden peas, several species of *Crotalaria*, lupin (*Lupinus angustifolius*), pigeon pea (*Cajanus cajan*) and yam bean (*Pachyrhizus erosus*). It was particularly destructive to soy beans and infested an average of 90 per cent. of the pods in Shatang, the lightest infestation observed over three years being 72·8 per cent. *Crotalaria* was also severely attacked. The different stages of the borer and the damage it causes are described. It had seven generations a year in Liuchow, the eggs and pupal stages lasting 4–6 and 9–20 days, and the larval stage 11 days or more. Larvae that became full-fed in autumn hibernated in cocoons in the soil near their food-plants and pupated in late March or early April. The moths migrated to soy beans as soon as the pods developed, but this did not occur until several generations had been produced on other food-plants, of which *Crotalaria* was the most important. In some cases, the period between emergence of the overwintered generation and the earliest infestation of soy beans was as long as three months, so that the infestation would have been impossible if intermediate food-plants had been absent. Some of the larvae had entered hibernation towards the end of October, before the soy beans were harvested, but some of those on *Crotalaria* continued to feed until cold weather set in. A species of *Trichogramma* was the only parasite found.

Eradication of the alternative food-plants of the Pyralid is recommended for control; *Crotalaria* required for green manure should be cut before its pods are formed. Soy beans planted during April were observed to be less damaged by the larvae than those planted later.

CHEU (Seh-pong). **Insect Menace—the Cause of Soybean Failure in Kwangsi.** [*In Chinese.*]—*Kwangsi Agric.* **4** no. 3 repr. 7 pp., 4 refs. Liuchow, 1944.

Attempts to grow soy beans in Shatang, Kwangsi, have failed for several years, and investigations carried out in 1940–42 showed that this was due to attack by insects. Of the 24 species collected, *Etiella zinckenella*, Treitschke, *Coptosoma punctatissima*, Mont., *Agromyza phaseoli*, Coq., *Mylabris cichorii*, L., and *Corigetus* sp. were the most destructive, and it is pointed out that this unusual abundance of injurious insects was largely due to the cultivation of green-manure crops, especially species of the genus *Crotalaria*, which served as intermediate food-plants for several insects attacking soy bean [*cf.* preceding abstract].

HOGAN (T. W.). **Pin-hole Borers of Fire-killed Mountain Ash. The Biology of the Pin-hole Borer—*Platypus subgranosus* S.**—*J. Dep. Agric. Vict.* **46** pt. 8 pp. 373–380, 8 figs., 3 refs. Melbourne, 1948.

This second paper on the results of investigations on pin-hole borers infesting the timber of fire-killed *Eucalyptus* in the Central Highlands of Victoria in 1942–44 [*cf. R.A.E.*, A **33** 377] comprises an account of the bionomics of *Platypus subgranosus*, Schedl. This Platypodid, all stages of which are

described, appears to be indigenous to Australia and has been recorded only from Queensland, Tasmania and Victoria. Examples were taken from *Eucalyptus regnans*, *E. gigantea*, *E. goniocalyx*, *E. obliqua* and *Nothofagus cunninghamii*. The method of study, which is described, involved opening up, at regular intervals, sections taken from infested wood of known history, which provided data on the seasonal occurrence of the different stages, the length of the life-cycle under field conditions and the types of gallery formed. For insectary rearing, it was found essential to prevent the drying of the wood by coating the ends of the sections with paraffin wax and spraying the sides with water, or coating the lower end only and supplying water from the top. Large numbers of adults for the artificial infestation of sections were obtained by enclosing naturally infested wood in a wire cage and using their attraction to light to trap them as they emerged ; they were subsequently kept alive for long periods in damp sawdust.

The initial entry into the wood is made by the male beetle, which penetrates to a depth of about $\frac{1}{2}$ in. ; the female is attracted to the male, and after pairing, extends the gallery for about 4–6 ins., at right-angles to the grain of the wood. Frass, consisting of splinters or fibres, is expelled until oviposition begins, after which the females do not excavate further. The eggs are laid singly or in small groups, usually near the end of the gallery ; not more than 6–10 are found in any one gallery at a given time. Oviposition is continuous over the warmer months ; most of the eggs appear to be laid in spring and autumn and very few in winter. No frass is produced during the period of larval growth, but the full-fed larvae expel a granular type of frass while mining out the cells in which they pupate. Up to 34 of these cells have been found in one tunnel. In the central Highlands, the adults emerge from October to late April, with peaks in January and March, but there are no definite broods. Emergence from one gallery sometimes continues over a whole season or may begin in one and continue in the next, and larvae are sometimes still present after adult emergence has begun. The flight of both sexes is weak and slow. An average of 9·8 adults emerged in the insectary from each entry ; of a total of 670, 337 were males and 333 females. The life-cycle probably occupies an average of 2–3 years, the rate of development depending mainly on temperature. It was as short as 10 months in wood of small diameter exposed to the sun and appeared likely to require 4–5 years under sheltered moist conditions in wood of large diameter. Only one generation develops in any one gallery.

Some weeks after the beetles enter the wood, the walls of the tunnel are stained black by a fungus, identified as *Leptographium lundbergia*, which penetrates a short distance into the surrounding wood, and with which a yeast is associated. The insects probably feed on the fungus and possibly on the yeast also. They do not appear to ingest wood. The fact that *L. lundbergia* is always present in the galleries of *P. subgranosus* and nowhere else in the wood suggests that it is carried by the adults, probably internally. This was confirmed by tests in which cultures of the fungus, with or without the yeast, were sometimes obtained from beetles that were immersed in a fungicide, washed in sterile water, and then transferred to malt agar slopes. The yeast without the fungus was obtained in a few of the cultures, but this occurred most commonly when larvae were tested.

Natural enemies of *P. subgranosus* were rare in the field, but two were found in wood brought from an area where the beetles were numerous and long-established. One of them was a mite of the genus *Schwiebea*, possibly *S. talpa*, Oudm., which caused considerable difficulty in rearing the insects and usually attacked them after the beetle had finished boring and before the full-fed larvae had begun. The other was the Colydiid, *Oxylaemus leae*, Grouv., which was taken in the field and from logs brought to the laboratory ; it appeared

to be a predator, as it did not bore into the wood, entered the galleries of *P. subgranosus* when confined near the entrance and was unable to survive in empty galleries.

O'Loughlin (G. T.). **Codling Moth Control. DDT Trials in southern Victoria.** —*J. Dep. Agric. Vict.* **46** pt. 10 pp. 442–444, 2 figs. Melbourne, 1948.

An account is given of tests of DDT spray schedules against *Cydia pomonella*, L., on apple in two orchards near Melbourne in 1947–48. Outbreaks of *Tortrix postvittana*, Wlk., unexpectedly developed in both of them [*cf. R.A.E.*, A **37** 26], and the observations were extended to include this Tortricid, which had rarely become harmful when lead arsenate was the standard spray against *Cydia*. DDT was used at 0·1 or 0·05 per cent. as a dispersible powder, and the dates of application were 3rd November for the calyx spray and the middle of November, December, January and February for the cover sprays. Three or four cover sprays were applied at Ringwood, where lead arsenate only had been used in the previous season, and two or three at Wantirna South, where DDT had been used in the previous year and the outbreak of *Tortrix* was more serious ; a supplementary cover spray of 6 lb. lead arsenate and ½ gal. white oil per 100 gals. was applied on 12th February to all the trees there in an unsuccessful attempt to control it. The calyx spray was omitted in some tests. The percentages of fruits damaged by *Cydia* and by *Tortrix* both decreased as the number and strength of the DDT sprays increased and ranged from 2·1 to 0·5 and 21 to 5·1, respectively, at Ringwood, and from 0·4 to 0·1 and 62·6 to 28·9 at Wantirna South. No significant differences in the control of *Cydia* resulted from the inclusion of calyx sprays in either locality, but infestation by *Tortrix* was significantly reduced, probably because DDT is more effective against the young larvae.

It is concluded that, in orchards where DDT has been previously used, two sprays of 0·1 per cent. DDT or three at half strength will give good control of *Cydia*. A district survey showed that, without exception, heavy damage by *Tortrix* was associated with the lack of early lead-arsenate sprays, and indicated that the inclusion of two such sprays will effectively control it.

Lever (R. J. A. W.). **Insect Pests in Fiji.**—*Bull. Dep. Agric. Fiji* no. 23, [5+] 36 pp., 8 pls., 1 map. Suva, 1946.

This bulletin contains a section in which notes are given on the habits, importance and control of the chief insect pests of crops in Fiji, arranged under the crops attacked, another dealing similarly with pests of stored products and insects that are harmful or troublesome in houses, a fourth and very brief one on the biological control of insects and weeds, and a fifth in which directions are given for using various common insecticides. In the first of the six appendices, the principal pests are listed under their natural orders, together with the plants or materials they attack. The others include a note on the relation between weather and outbreaks of certain insects in Fiji, instructions for the packing and despatch of insect specimens, notes on the control of a few garden pests other than insects, and emergency measures for the treatment of accidental poisoning of man by insecticides.

Notes and Exhibitions [presented at meetings of the Hawaiian Entomological Society in 1945].—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 463–492, 1 ref. Honolulu, 1946.

Achaea janata, L., which had not previously been recorded in the Hawaiian Islands but had been found in aircraft arriving at Honolulu, was observed on

Oahu in December 1944 and was widespread on this island in 1945. The larvae defoliated castor (*Ricinus communis*) and were also found on *Euphorbia bifida*, *E. hirta*, *Leucaena glauca*, *Desmanthus virgatus*, *Acacia farnesiana*, *Prosopis chilensis*, *Codiaeum*, and a species of *Polypodium* (one example). The Ichneumonid, *Hyposoter exiguae*, Vier., was reared from larvae on *E. bifida*, the Tachinids, *Blondelia* (*Eucelatoria*) *armigera*, Coq., and *Chaetogaedia monticola*, Big., from larvae and pupae on castor, and all the eggs collected, which were laid singly, yielded adults of *Trichogramma minutum*, Ril. In 1945, this Noctuid was also found on Kauai and on castor on Hawaii.

Adults of *Anacamptodes fragilaria*, Grossbeck, a Geometrid native to southern California, were taken at Pearl Harbour in August 1944 and over most of Oahu in February 1945, occurring on Mount Tantalus to a height of 1,600 ft. The larvae were found feeding on the leaves of some 30 different plants, including many ornamental flowering trees and several important forage trees and shrubs, and sometimes caused considerable defoliation. Eggs were found in March under bark on the trunks of *Prosopis chilensis*, where they were protected from attack by *T. minutum*. No parasites were obtained from eggs collected in the field, though *T. minutum* parasitised them readily in the laboratory. Numerous adults of *Pimpla* (*Ephialtes*) *hawaiiensis*, Cam., were observed in March hovering over soil that thinly covered many pupae and prepupae of *A. fragilaria*, but no adults of this parasite were reared from about 150 pupae collected in the field. In the laboratory, it readily attacked pupae, prepupae and even larvae, and though only a small proportion of the attacks resulted in oviposition, it developed successfully in the pupae, the adults emerging 16 days after oviposition. *P. hawaiiensis* also attacked pupae of *Achaea janata* in the laboratory, but it was not ascertained whether it parasitised them successfully.

It is reported that a Jassid tentatively determined as *Draeculacephala mollipes*, Say, has become important in watercress beds on Oahu since September 1944, when it first reduced production seriously. It is present throughout the year, but most injurious in summer. There appear to be two types of injury ; one has the appearance of a disease, but is seemingly associated with infestation by the Jassid, as it ceases to increase when the latter is controlled by rotenone. *Draeculacephala* has been observed in the beds since early 1942, and its sudden increase may be due to favourable weather or to the recent increase in the production of watercress. In 1942, the addition of copper sulphate to the irrigation water for the control of crayfish appeared to reduce the numbers of leafhoppers.

Brachycolus heraclei, Takah., an Aphid that was first observed on celery on Oahu in December 1940 and has since been found on Maui and Hawaii, increased to an alarming extent on crops nearing maturity on Oahu in April 1945, owing to the shortage of suitable insecticides. If the plants are infested when young, serious retardation of the crop may result, and the importance of the Aphid has increased considerably of recent years, since celery for the local market is now largely produced in Hawaii. The Delphacid, *Ilburnia ipomoeicola*, Kirk. (sweet-potato leafhopper), was reported on Hawaii, and its eggs were found in the stems of sweet-potato plants. A female of the sweet-potato vine-borer, *Omphisa anastomosalis*, Gn., collected at light on 12th May deposited 70 eggs overnight. The larvae hatched on 18th May and were put among numerous sprouts on a sweet-potato tuber in a jar. They entered the sprouts at the axils and, after destroying them, bored into the tuber. Pupae were found in cocoons in the burrows on 14th June, and adults emerged from 26th June to 9th July. D. T. Fullaway proposes the new name *Apanteles tapatapaoanus* for the Braconid parasite of a species of *Bedellia* on sweet potato in Samoa described by him in a paper already noticed [*R.A.E.*, A **31** 65] as *A. bedelliae*, since it is distinct from *A. bedelliae*, Vier. [*cf.* **10** 335 ; **27** 375], which was bred from *Bedellia*

in Washington, D.C. *A. bedelliae*, Vier., was introduced from Kansas during the summer of 1945 and became established in a few localities on Oahu.

Spiders of the genus *Latrodectus* are recorded as binding the growing central leaves of pineapple on Maui and causing abnormal growth. Adults of the Tenebrionid, *Blapstinus dilatatus*, Lec., were found injuring watermelon plants in Oahu in September 1944. They caused the plants to wilt by chewing the stems 2–3 ft. from the base. A general infestation of watermelons by *Heliothis armigera*, Hb., was reported on Molokai. The larvae attacked the plants in all stages of growth, causing drying of the tissues along the walls of the feeding channels and fermentation within the fruits. Of the 56 acres of water melons grown on Molokai in June 1945, about 75 per cent. were damaged, and there was an estimated loss of 50 per cent. of the entire crop. A few examples of *Dacus cucurbitae*, Coq., were reared from some of the melons. The attack by *H. armigera* may have been due to the fact that whereas 1,200–1,500 acres of maize were grown on the island in 1944, there was very little left by June 1945, so that the large populations of moths that had developed oviposited on melon in the absence of the favoured food-plant. Severe damage to banana fruits by *Hercinothrips femoralis*, Reut., was again reported from Oahu [*cf.* **34** 274]. On Molokai, larvae of *Cryptorrhynchus mangiferae*, F., injured mango seeds intended for planting, and adults were observed feeding on two large fruits, one of which was still on the tree.

Orchidophilus peregrinator, Buchanan, materially reduced the production of *Vanda* blooms in a commercial orchid garden on Oahu. Injury resulted principally from the feeding of the adults on the buds and of the larvae in the leaves and aerial roots. It was controlled more effectively by DDT than by other insecticides tested. *Aleurodes spiraeoides*, Quaint., is recorded on *Iris* on Maui, and *A. schizuokensis*, Kuw., on *Oxalis* on Oahu, both for the first time in the Territory, though the latter has been known there for 20 years. In May 1945, a single alate of *Capitophorus chrysanthemi*, Theo., and apterae and alates of *Rhopalosiphum* (*Coloradoa*) *rufomaculatum*, Wils., were found on chrysanthemum on Oahu.

A heavy infestation by *Aphis maidis*, Fitch, observed on successive plantings of sweet maize at a farm on Oahu from May or June until September was probably the result of the growing of a susceptible variety and the cultivation of maize for several successive years on the same farm, as well as possibly of favourable weather. A parasite, apparently *Aphidius* (*Lysiphlebus*) *testaceipes*, Cress., increased in abundance during September, but it was still not numerous enough by the last week of the month to prevent heavy infestation of new plantings. Three applications of a nicotine spray controlled the Aphids during the early growth of the crop, but heavy infestations had developed by the time the maize was 4–5 ft. high and difficult to treat. Aphids in the unexpanded young leaves were not parasitised. During the last week of September, heavy rains reduced the population considerably, the healthy Aphids being washed off the leaves, whereas parasitised ones remained.

The introduced Encyrtids, *Anagyrus coccidivorus*, Doz., and *Hambletonia pseudococcina*, Comp. [*cf.* **25** 552] were apparently controlling *Pseudococcus brevipes*, Ckll., on pineapple in one locality on Maui where the dominant ant was *Paratrechina longicornis*, Latr.; parasitism was high and pineapple wilt scarce. *Leptomastix dactylopii*, How., which was accidentally introduced from California, was found established on a mixed infestation of *Pseudococcus kraunhiae*, Kuw., and *Phenacoccus gossypii*, Towns. & Ckll., on soy beans and egg-plant [*Solanum melongena*] in Honolulu. Larvae of *Acrolepia assectella*, Zell., collected on green onions at the University of Hawaii, were found to be parasitised by *Chelonus blackburni*, Cam.

Fresh leaves of nutgrass [*Cyperus rotundus*] from a sugar-cane field were found to have 13 eggs of *Bactra truculenta*, Meyr., on the undersides, of which

12 were parasitised by *Trichogramma minutum* [*cf.* **31** 46]. An unidentified species of *Procecidochares* recently introduced from Mexico for the control of *Eupatorium glandulosum* was reported in August 1945 to be established on Mount Tantalus, Oahu, and on Maui. Fresh galls on the stems of *Eupatorium* had been noticed on Tantalus for several months, but the establishment on Maui was very recent, as shipments to that island were not made until the middle of May. Evidence was obtained that *Opius* (*Diachasma*) *tryoni*, Cam., and *Eurytoma* sp. parasitise this Trypetid.

Bianchi (F. A.). **Additions to the Thysanoptera from the Island of Hawaii.**—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 503–514, 9 figs. Honolulu, 1946.

The author lists 25 species of thrips additional to those recorded from the island of Hawaii in recent papers [*R.A.E.*, A **34** 275, 277]. They include three new species, which are described, one species that is new to the Territory, and *Podothrips lucasseni*, Krüg., *Anaphothrips swezeyi*, Mltn., and *Thrips saccharoni*, Mltn., all three of which were abundant on sugar-cane.

Jensen (D. D.). **The Identity and Host Plants of Blossom Midge in Hawaii (Diptera : Cecidomyiidae :** *Contarinia*).—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 525–534, 14 refs. Honolulu, 1946.

A Cecidomyiid of the genus *Contarinia* found infesting the buds and flowers of tomato in Hawaii has been recorded as *C. solani*, Rübs., which was originally described from *Solanum dulcamara* in Germany, and as *C. lycopersici*, Felt, which was described from tomato in St. Vincent, West Indies, and is widely distributed in the Caribbean area [*cf. R.A.E.*, A **30** 169]. Barnes considered that the species on tomato in Hawaii was probably *C. lycopersici* [**25** 743], and it was subsequently recorded under that name from tomato, egg-plant (*S. melongena*) and garden peppers (*Capsicum frutescens*) on Oahu [**35** 66]. In an investigation on the identity, ecology and bionomics of the midge begun on Oahu in 1944, Cecidomyiids from bitter melon (*Momordica charantia*) in the field and *Brassica chinensis* in a greenhouse appeared identical with those from tomato, and similar midges were also reared from other species of *Lycopersicum*, potato and *S. rantonnetii*. In January 1945, an infestation on tomato was found to increase in intensity in the direction of a *Hibiscus* bush growing in one corner of the field, 80 per cent. of the buds on which were infested by midge larvae, and the adults reared from *Hibiscus* and tomato appeared to be identical. The *Hibiscus* bud midge of Hawaii was described by Felt as *C. maculipennis* [**22** 112] and has also been reported from *Jasminum sambac*. Since it seemed likely, however, that only one species was involved on all these different food-plants, rearing experiments were carried out. Adults reared from *Hibiscus* and *J. sambac* bred on tomato in the laboratory and the duration of the life-cycle did not differ from that of the progeny of midges reared on tomato. The adults appeared similar in each case. Specimens from all the known food-plants except *Lycopersicum* (other than tomato) and potato were sent to Barnes, who compared them with specimens of *C. lycopersici* from tomato in Trinidad and Barbados and *C. solani* reared in England. He concluded that the midges from the various food-plants in Hawaii probably represent a single species. They agreed more closely with the original description of *C. maculipennis* than with that of *C. lycopersici*, whereas most of the material from the West Indies was closer to *C. lycopersici* than to *C. maculipennis*, except certain individuals from Trinidad, which closely resembled the specimens from Hawaii. In view of the variation in the accepted specific characters and the biological evidence, he considered that *C. maculipennis* is probably a synonym of *C. lycopersici*, but

retains the name until the ability of the West Indian *C. lycopersici* to breed on the food-plants reported from Hawaii has been tested experimentally.

Collection records of the midge in Hawaii are shown in a table. Infestation ranges from 1 to 80 per cent. of the mature buds of tomato, sometimes affects all the flowers of peppers in small gardens and is high at times on egg-plant. There are only two records from potato, possibly because damage to the flowers is of no economic importance. Infestation is also low on *Momordica*, but it is sometimes high on *Hibiscus* and was found in January 1945 on 75 per cent. of the buds of *J. sambac*, which is a perennial grown commercially for the flowers and is apparently an important food-plant. Breeding probably continues throughout the year on some of the solanaceous plants, though damage has most frequently been reported in the spring and early summer. A range of food-plants involving five families is unique among Cecidomyiids.

Jensen (D. D.). **Virus Diseases of Plants and their Insect Vectors with special Reference to Hawaii.**—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 535–610, 254 refs. Honolulu, 1946.

This presidential address consists of an account of the principles of insect transmission of plant viruses, based largely on the literature, lists of the insects recorded as vectors that occur in Hawaii, showing the viruses transmitted by each, and reviews of work, mainly carried out in other countries, on the insect transmission of the virus diseases known or reported to occur in plants in Hawaii. A list is also given of arthropods other than Aphids and Jassids that have been reported to transmit plant viruses in any part of the world, showing the viruses concerned.

McKenzie (H. L.). **A new Species of** *Lepidosaphes* **attacking** *Dendrobium* **Orchids in Hawaii and California (Homoptera : Coccoidea : Diaspididae).**—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 611–613, 1 fig. Honolulu, 1946.

Lepidosaphes noxia, sp. n., is described from examples taken on *Dendrobium dearei* in California and material submitted on pseudobulbs of the same orchid from Honolulu, Hawaii, both in 1944. It was said to have been injurious in Honolulu for several years, and the pseudobulbs showed marked damage, causing the death of the leaves where these were attached to the leads. Characters are given distinguishing it from *L. mackieana*, McK., and *L. newsteadi*, Šulc.

Swezey (O. H.) & Zimmerman (E. C.). **Synonymic Notes on** *Argyroploce illepida* **(Butler) and** *A. carpophaga* **(Walsingham) (Lepidoptera : Eucosmidae).**—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 629–631, 1 pl. Honolulu, 1946.

In the first of these notes, Swezey considers that Meyrick was wrong in synonymising *Argyroploce carpophaga*, Wlsm., which was originally described from India, with *A. illepida*, Btlr., described from Hawaii. Moths reared from the seeds of several leguminous trees, including *Poinciana regia*, *Adenanthera pavonina* and *Pithecolobium dulce*, in Guam in 1936, agreed with Walsingham's description and figure of *A. carpophaga*, but differed from *A. illepida* from the seeds of *Acacia koa*, *A. farnesiana* and several other leguminous trees in Hawaii, and *Poinciana*, *Adenanthera* and *Pithecolobium* were not attacked there. The morphological differences observed are described. So far as is known, *Argyroploce illepida* is restricted to the Hawaiian Islands, so that records of its occurrence elsewhere [*cf. R.A.E.*, A **8** 445 ; **16** 249 ; **17** 244 ; **18** 444 ; **26** 497 ; **29** 137, 182, 496 ; **30** 371] doubtless refer to *A. carpophaga*.

In the second, Zimmerman reports that examination of the male genitalia confirms that *A. illepida* from Hawaii and the widespread *A. carpophaga* are distinct. From the examination of numerous examples, he concludes that there is only one species of *Argyroploce* in Hawaii, *A.* (*Cryptophlebia*) *vulpes*, Wlsm. [**7** 511] being a synonym of *A. illepida*.

Pickles (A.). **Insecticidal Control of the Sugar Cane Froghopper.**—*Proc. agric. Soc. Trin. Tob.* **46** pt. 2 pp. 149–153, 5 figs. Port-of-Spain, 1946.

In view of the promising results obtained with dusts of sabadilla and DDT applied by the drift-dusting method in July 1945 for the control of adults of the sugar-cane froghopper [*Tomaspis saccharina*, Dist.] in cane fields in Trinidad [*cf. R.A.E.*, A **35** 141], which are described, further tests were made in August 1946. A dust containing 33 per cent. sabadilla and 6 per cent. DDT in ground limestone, applied on 13th August, when the adult population was increasing rapidly despite an application of sabadilla and ground limestone (1 : 2) on 9th August, not only gave satisfactory immediate mortality but also prevented the population from again attaining a seriously destructive level. The results were better in the half of the field near the dusting machine than in the other, but as the DDT carried further than the sabadilla, the effect of the residue was more noticeable in the leeward part. In a further comparative test, dusts of benzene hexachloride (666) and DDT were applied in late August under poor weather conditions. Benzene hexachloride gave high immediate mortality, and there was no appreciable increase in the adult population during the following nine days, although, as the numbers were declining naturally, no definite evidence of prolonged action was obtained. The effects of DDT were slow and cumulative, but similar to those of benzene hexachloride after about five days.

Notes on Froghopper Control.—*Proc. agric. Soc. Trin. Tob.* **46** pt. 3 pp. 235, 237–242. Port-of-Spain [1947].

An account is given of work in 1945–47 in which DDT dusts were tested against the sugar-cane froghopper [*Tomaspis saccharina*, Dist.] on an estate in Trinidad. Except where otherwise stated, they were applied by the drift-dusting method [*cf. R.A.E.*, A **35** 141], a single application consisting of two treatments, one aimed at the near side of the field by holding the nozzle about 2 ins. above the front row of canes and directing it upwards at an angle of 45°, and the other aimed at the far side, in which the angle was 60°.

In a preliminary test in September 1945, an application of 2 per cent. DDT in sulphur did not prevent a rise in population for the first two days, but gave reasonably high mortality thereafter. In 1946, various proprietary DDT dusts were diluted with sulphur or pulverised limestone to contain 5 per cent. DDT and applied to heavily infested fields in many of which the population averaged as many as 20 adult froghoppers per stem. The treatment reduced infestation to a maximum of two adults per stem and gave complete mortality after 48 hours in a number of fields. It was effective even in fields in which nymphs were numerous when it was applied and adults were emerging at the rate of four per stem per day, because contact with the DDT residues paralysed the newly emerged adults so that they did not reproduce although they remained alive for some time. It thus appeared that if a field was treated for the first or second brood, no subsequent brood would occur throughout the season, and nearly all the fields dusted in 1946 were less infested in 1947 than the others. All the DDT preparations were satisfactory, but a wettable powder containing 50 per cent. DDT was better than the others, chiefly because of the more prolonged effect of its residues, and it was accordingly selected for use in 1947.

In that year, a system of regular field inspections was adopted, daily records of populations were kept, and the fields were dusted, usually with 6 per cent. DDT, as soon as they showed a minimum of four first-brood adults per eight stems. Control was excellent, and no subsequent broods appeared in treated fields. Second and third broods developed in fields that had not been dusted because infestation by the first brood had not reached the necessary minimum, and it is concluded that lower first-brood populations should be treated if subsequent broods are to be avoided. The number of applications required varies; two are usually necessary in heavily infested fields. The figures for certain fields with populations of 1–5 first-brood adults per single stem and over 100 nymphs per stool are given in detail. They were treated 1–3 times, and each application gave over 90 per cent. mortality, so that there was no recurrence of infestation throughout the season. In one field, a 9 per cent. DDT mixture was applied by hand dusters to canes bearing an average of 150 nymphs per stool. No appreciable reduction occurred until the fifth day, but on the tenth day all the froghoppers had disappeared. Daily counts showed no rise in the adult population throughout this period.

Frear (D. E. H.). **A Catalogue of Insecticides and Fungicides. Volume II. Chemical Fungicides and Plant Insecticides.**—*Ann. cryptog. phytopath.* **8** xii+153 pp., frontis., 5½ pp. refs. Waltham, Mass., Chronica Botanica Co.; London, Wm. Dawson & Sons, Ltd., 1948. Price $5.50 or 33*s*.

The data in this second volume are presented in the same way as those in the first [*R.A.E.*, A **36** 297]; it contains the sections on fungicides and one on plant insecticides, and an alphabetical index to all the chemical compounds dealt with in the two volumes. The introductory chapter explaining the coding system, which is adopted for the chemical fungicides, is repeated; the plant insecticides are recorded under the plants in alphabetical order, but the information on particular plant products, such as nicotine or rotenone, is given in the first volume.

Baker (K. F.), Snyder (W. C.) & Holland (A. H.). *Lygus* **Bug Injury of Lima Bean in California.**—*Phytopathology* **36** no. 7 pp. 493–503, 2 figs., 30 refs. Lancaster, Pa., 1946.

The following is based on the authors' summary. Lima beans in California commonly show a necrotic pitting of the seed closely resembling, except for the absence of any pathogen, the yeast-spot disease of beans that occurs in the eastern United States and is there attributed to *Nematospora coryli* (*phaseoli*) [*R.A.E.*, A **32** 154]. Similar damage occurs on blackeye cowpea, but has not been observed on common beans in California. Field and greenhouse tests in which *Lygus* spp., including *L. hesperus*, Knight, and *L. elisus*, Van D., were caged on lima beans showed that the pits resulted from toxic feeding of the Mirids on the developing fruiting structures. The injury cannot be distinguished from yeast spot by symptoms alone, and the possibility that the latter is caused primarily by insect toxins and not by the fungus should be considered.

The insects also cause, by toxic feeding, a shedding of blossoms and of pods up to 2 ins. long, and this usually comprises the most important loss in California, amounting in small areas to the total crop. Further losses result from the reduction in quality of the marketable produce and the cost of the necessary hand-sorting. Some young seeds become shrivelled as a result of the feeding, but other undetermined factors appear to be of greater importance in causing this damage. In a field test in July 1945 in which the controls showed 16·1 per cent. pitted seeds, with as many as 52 punctures per seed, an application of a dust containing 4 per cent. DDT in sulphur at a rate of

30 lb. per acre reduced injury by *Lygus* to the green pods and resulted in significant increases in the numbers of green and dry pods, the number and weight of beans, and the percentage of unpitted seeds. There was a decrease in dry plant weight exclusive of pods in the dusted plots, but this approximately equalled the increase in the weight of the dry pods.

Damage tends to be more severe in fields adjacent to established, perennial, preferred food-plants of *Lygus*, such as beet grown for seed and lucerne. In some areas, the bugs may be present for a relatively short time on lima beans and injure only part of the field and part of the pod set ; in other areas, they remain active on the beans throughout much of the season and injure most of the pods in whole fields.

VOELCKER (O. J.). **Annual Report of the West African Cacao Research Institute, April, 1944 to March, 1945.**—36 pp. Tafo, 1946. **April, 1945 to March, 1946.**—61 pp. 1947. **April, 1946 to March, 1947.**—70 pp. 1948.

These three reports of investigations on cacao carried out mainly at Tafo in the Gold Coast and Owena in Nigeria each contain sections dealing with research on viruses and on Mirids (Capsids). With regard to the former, it is stated in the first report that the symptoms produced in cacao infected with the swollen-shoot disease differ locally and appear to be caused by different strains of the virus. The characteristic symptoms of eight strains are shown in a table with the severity of the disease produced by each, its development period and the part of the Gold Coast in which it was found. The strains are A (New Juaben), B (Bisa), C (Kpeve), D (Nkawkaw), E (Pamen), F (Wiawso), G (Dochi) and H (Dawa). The most virulent are A and H, which cause defoliation and rapid die-back and usually destroy the trees in 2–3 years, and F, which causes defoliation, slow die-back and premature death. Additional strains recorded in the third report are F_1 (Wiasi), F_2 (Bosumuoso), J (Bosomtwe), K (Konongo) and M (Mampong), all from the Gold Coast, N_1 (Olanla A) and N_2 (Olanla B) from Nigeria, and the Appropronou and Kongodia strains from the Ivory Coast, Wherever local outbreaks were carefully examined, there were marked differences in symptoms and virulence within the general local symptom pattern. It is stated in the second report that mild strains are known in the Ivory Coast, Western and Eastern Provinces of the Gold Coast, Ashanti and Togoland and are typical of Nigeria, whereas virulent strains affect a considerable acreage concentrated in the Eastern Province, with scattered outbreaks in Ashanti, the Western Province and the Ivory Coast. In the mild outbreaks, dead and moribund trees are scarce, and there may be no discernible effect or only slight deterioration of the canopy.

Attempts to transmit strains A, B and C alone or in combination through the seeds of infected trees, which are reported in the first and second reports, were unsuccessful. The results of experiments on insect transmission are summarised in the third report. *Pseudococcus njalensis*, Laing, transmitted strains A, B, C, D, F_1 F_2, J, K, M, N_1, N_2, and the Appropronou and Kongodia strains, *P. citri*, Risso, transmitted A, C and D, *Ferrisia virgata*, Ckll., transmitted A and M, and *P. concavocerarii*, James [*R.A.E.*, A **22** 353] transmitted A. In tests described in the second report, *P. njalensis* and *F. virgata* did not transmit C and F, and *Toxoptera aurantii*, Boy. (*coffeae*, Nietn.) and *Mesohomotoma tessmanni*, Aulm., did not transmit A, B, C, D, or F. Tests on the transmission of strain A by *P. njalensis* are also described in this report. Adults and nymphs in each of the three instars all transmitted the disease after feeding on the leaves, shoots or bark of infected plants for less than four hours ; most transmissions (80 per cent.) took place when adults fed on the flush leaves of the source plant for 48 hours. Symptoms developed most rapidly (in 17 days) when plants were infested with vectors 4–5 days after the

flush leaves had hardened. Young cacao plants still with cotyledons developed typical leaf symptoms when infested with mealybugs that had fed for 48 hours on the flush leaves of infected plants. In the third report, feeding for less than four hours on the pods of diseased trees is stated to render the mealybugs infective. Healthy plants became infected with strain A after vectors had fed on them for less than three hours and vectors that had fed were no longer infective after that period, though starved ones remained so for at least five hours and strain M was transmitted by *P. njalensis* that had not fed for 12 hours. This mealybug varied in its effectiveness in transmitting the different strains and gave high and low rates of transmission of the same virus under the same conditions, indicating that there are active and non-active races. Cacao beans were used effectively as test plants in transmission tests, the symptoms appearing on the first or second flush leaves produced after germination.

In an account of experiments on the behaviour of strain A given in the first report, it is stated that 44 per cent. of a large number of healthy trees infected with it were destroyed and the rest rendered moribund in 18 months. Neither of the mild strains B or C rendered trees on which they were budded immune from it. It was found that the virus moved from the infected scion to the stock in less than 24 days, is not usually carried in the xylem and differs from strain C in its reaction to staining [**35** 89]. In the second, it is stated that it may be a complex of at least two strains, that it and a strain closely resembling strain B were transmitted by *F. virgata*, and that it appears to be unstable ; in connection with this lack of stability, it is pointed out that the relative distribution of mild and virulent strains support the theory that the latter have developed from the former. A quantitative test described in the third report showed that the order of decreasing virulence of some of the strains to cacao seedlings was A, H, K, D, M, J, F, C, attenuated A and B ; these results correspond with visual estimates except in the case of C, of which an attenuated form may have been used. In cross-immunity tests, attenuated A and strains H and K gave complete, and strains C, F and J no protection against strain A, and strain B doubled or trebled the latent period before the appearance of its symptoms ; when A and M were present in the same plant, each developed as though in the absence of the other, but they occasionally formed a local complex, which was transmitted by *P. njalensis*.

Trees infected with strain B in 1942 showed no significant reduction in yield during 1943–46, but others infected with strain C produced nearly 50 per cent. fewer pods in 1945–46 and there was also a significant reduction in the weight of wet beans per pod ; trees infected with strain A produced significantly fewer pods in 1943–44 and a negligible crop in 1945–46. The percentage of infected trees at Tafo increased from 31 in August 1945 to 55 in March 1947, during which the yield decreased by 19 per cent., and since the increase occurred in numerous independent outbreaks, in which it varied from 10 to 100 per cent., and was not associated with tree density, it was attributed to variations in the vector populations. Investigations showed that *P. njalensis* was the most and *P. citri* the next most abundant mealybug ; *F. virgata* was not found. Of 79 trees examined in August 1946, 27, of which 15 were diseased, were infested with the mealybugs, and of 71 examined in February 1947, 39, of which 16 were diseased, were infested. Over the same period, the numbers of mealybug colonies and of individual mealybugs (*P. citri* and *P. njalensis*) had increased from 103 to 314 and from 316 to 782, respectively. Of 91 feeding colonies of *P. njalensis* on 20 trees, 8 on leaves, 33 on bark and 11 on pods were in the canopy, and 22 on bark and 17 on pods were on the trunks. Most of the mealybug colonies were attended by ants.

It is stated in the second report that eggs of *P. njalensis* usually hatch in less than 12 hours, the successive nymphal instars are completed in 4–6, 10–14 and 10–14 days, and the adult females live for 14–30 days. Dispersal takes

place by free movement on the plants and occasionally over the ground, and by means of ants, by wind (in the case of crawlers in the first two instars), and on nursery stock and harvested pods. The results of further observations, given in the third report, show that the periods of survival without food are not more than two days for crawlers, four for third-instar nymphs and young adults and more than ten for mature adults. The males do not feed, and reproduction appears to be largely parthenogenetic, though the parthenogenetic capacity of the females decreases rapidly after three parthenogenetic generations. This mealybug, which is negatively phototropic, has been recorded on over 100 indigenous and introduced plants [*cf.* **36** 111], of which cacao, *Desplatzia dewevrei*, *Artocarpus communis* (*incisa*), *Canthium glabriflorum* and *Cola chlamydantha* are preferred. Over 30 species of ants have been taken in association with it, but most of them are not obligatorily coccidophilous and some are actively predacious on the nymphs. It is parasitised by a Cecidomyiid and three Hymenoptera [*cf.* **36** 111], but it appears to be checked chiefly by climatic factors, since heavy rain storms often destroy colonies within a few hours. Populations are of the order of 40,000 per acre, occurring mostly as small scattered colonies in the canopy, and control by insecticides therefore appears impracticable. Some of the information on *P. citri* and *F. virgata* in the third report is similar to that already noticed [**36** 110–111]. *P. citri* has not been recorded on *Citrus* in the Gold Coast, and though it attacks over 60 other plants there, infestation is light except for a few large colonies on cacao pods. It is less numerous on cacao in the Eastern Province than *P. njalensis*, but appears to be the commoner species on cacao in Nigeria. The life-cycle, egg and nymphal stages of *F. virgata* occupy about 44 days, one day, and 3–4 weeks, respectively. The young nymphs are frequently distributed by wind. A list of 18 other Coccids that have been taken on cacao is given in the second report.

Virus infection among young cacao planted on sites from which diseased trees had been removed [*cf.* **35** 88] is stated in the second report to have been low except where some diseased trees had been left. Experiments on the regeneration and vigour of coppiced healthy and diseased cacao, which are described in the second report, showed that the survival rate among healthy trees is high and that although most diseased trees die relatively soon, too many of them persist temporarily for this method of removing them to be efficient. Certain diseased survivors with very mild symptoms appeared to be as vigorous as healthy ones and might survive indefinitely. The results of investigations into this apparent recovery are presented in the third report and lend some support to the theory that such trees are infected by a mild virus that is confined to the lower parts of the tree, the symptoms of which are masked before coppicing by a severe virus predominant in the upper part. Work on varieties of cacao resistant to the disease is described in the first two reports and it is stated in the second that only six clones of more than 500 derived from healthy or apparently mildly diseased trees on devastated farms appear to be strikingly resistant. Of 25 clonal selections from trees at Aburi, seven showed conspicuous vigour despite infection for three or four years.

The results of investigations on alternative host plants of strain A are given in the third report. In tests of transmission by mealybugs and by grafting, with cacao as the virus source and test plant, both methods were successful with *Theobroma bicolor* but failed to give definite results with indigenous plants, though seedlings of *Bombax buonopozense* developed virus-like symptoms. Transmission from three plants of *Cola chlamydantha* to cacao was obtained, however, in tests in which mealybugs were transferred to cacao from plants suspected of natural infection.

With regard to Mirid research, each report contains information on the bionomics of *Sahlbergella singularis*, Hagl., and *Distantiella theobroma*, Dist.

[*cf.* **35** 87]. In the first, it is stated that the development periods at Tafo occupied about 35–46 and 31–41 days, respectively. Females lived for several weeks and laid up to 192 and 106 eggs. Similar results were obtained in studies of both species at Owena, which are given in the second report. Both are attracted to breaks in the canopy, but females kept in the shade laid more eggs than others kept in sunlight, among which mortality was so great that the experiment was discontinued. At Tafo, populations of *Sahlbergella* on pods increased rapidly in November–December 1945, after the bulk of the pods had been harvested; maximum total populations amounted to some 800 per acre. Numbers were negligible during May–August 1946, reached maxima, which were considerably lower than in previous years, on pods in November and on vegetative parts in January 1947, and were again negligible by March. Populations of *Distantiella* had no well defined peak during 1945–46, and in the following year showed fluctuations similar to, but smaller than, those of *Sahlbergella*. Mirid damage in Nigeria was greatly reduced during 1945–46, possibly owing to the severe and prolonged dry season of 1944–45. Populations of *Sahlbergella* on pods at Owena reached a peak in August 1946 owing to the presence of a large mid-crop and were low from December onwards; populations on the vegetative parts also reached a maximum in August and were low for the rest of the year, but the reduction was probably due to the removal of the basal chupons [shoots usually arising from the main stem], on which most Mirids are found, which is carried out about August. Observations at Akwadum and Tafo, which are described in the second report, confirm the view that low populations can cause considerable damage to seedling cacao. *Bryocoropsis laticollis*, Schum., was taken in Nigeria for the first time during 1945–46, when nymphs and adults were found feeding on the fruit and flowers of *Uvaria* sp. at Owena. The damage to the fruit was less extensive than that caused to cacao pods, on which *B. laticollis* was found to feed readily but not to oviposit. This Mirid has not been taken on cacao at Owena and its range on this food-plant is probably restricted to the Eastern and Central Provinces of the Gold Coast.

An experiment described in the first report showed that maximum damage resulting from feeding by *Sahlbergella* or *Distantiella* caged for 24 hours on three-year-old potted plants occurred within 24 hours and had not increased 30 days later, from which it appears that the direct action of the toxin injected during feeding [**35** 87] is soon spent. Work on the association between Mirid damage and the fungus, *Calonectria rigidiuscula* [**37** 70], is described in the second and third reports. The formation of Mirid pockets (localised areas of intense perennial damage by Mirids, chiefly *Sahlbergella*, that are characterised by the death of the canopy twigs and later of the trunk), which was formerly attributed entirely to Mirids, appears to be due to the fungus. In 1945–46, both *Sahlbergella* and *Distantiella* were present in Mirid pockets in each month from September to March, *Sahlbergella* being the more numerous. It comprised 80 and 88 per cent. of the Mirids present in trees 15–25 and 25–30 years of age, whereas *Distantiella* comprised 90 and 64 per cent. of those in trees 5–10 and 10–15 years old. Of the nymphs that hatched from eggs deposited in the pockets, 49 per cent. were lost, either because they moved away or because they were destroyed by predacious Mantids, Reduviids and spiders, which were numerous. Attempts to initiate Mirid pockets in healthy cacao are described in the third report. Where breaks in the canopy due to the falling of a large forest tree were simulated by pollarding the cacao at a height of about 6 ft., large populations of both *Distantiella* and *Sahlbergella* were built up, the former being dominant in trees 20 years of age that had a good canopy and the latter in similar trees with a poor but undamaged canopy and in trees 12–15 years old. The density of the Mirids depended on the number and size of the chupons available and was therefore highest on the young trees and

those with a good canopy. The cacao surrounding the pollarded plots was unaffected by the Mirids. The presence of both the fungus and the Mirids appears to be necessary for the maintenance of a pocket. The weak growth produced by branches attacked by both is so susceptible while still green to Mirid damage that a single lesion may be fatal. Mirid control is therefore less likely to be effective in inducing regeneration of the canopy than coppicing to remove infected wood, which is followed by vigorous growth, though an experiment showed that Mirids could prevent regeneration following coppicing unless the chupons were protected by painting with DDT in an emulsified solution. It is stated in the second report that there appears to be no correlation between degree of Mirid damage and soils, though recovery is retarded where the moisture content of the soil is low.

In experiments on alternative food-plants of *Distantiella* and *Sahlbergella* at Tafo and Owena described in the second report, cacao was generally preferred, but the relative succulence of the plants available is believed to be of importance. In Sierra Leone, there is some evidence of correlation between the presence of *Sahlbergella* on cacao and the proximity of *Ceiba*, but none has been found between the presence of *Ceiba* and perennial centres of Mirids on cacao at Tafo, and neither *Distantiella* nor *Sahlbergella* has been recorded on cacao in the Ibadan (Nigeria) area, though *Distantiella* feeds on *Ceiba* in the immediate vicinity. At Owena, nymphs and adults of *Sahlbergella* were found on commercial cola (*Cola nitida* ?) and caused damage similar to that on cacao, and typical Mirid damage was observed on *Cola togoensis* and *C. cordifolia*. An experiment described in the third report showed that the life-history of *Sahlbergella* occupied about equal periods on cacao and *C. cordifolia*, but was rather longer on *C. togoensis* and *Ceiba pentandra*. *Sahlbergella* was taken for the first time on *Ceiba* in the Gold Coast during 1946–47, when nymphs and adults were found on shoots arising from a stump. *Distantiella* is common on *Ceiba*.

Data on parasitism of *Sahlbergella* by *Euphorus sahlbergellae*, Wlkn., at Tafo are given in all three reports, and on parasitism by *Euphorus* and hyperparasitism by *Mesochorus melanothorax*, Wlkn., at Owena in the second and third. The highest parasitism by *E. sahlbergellae* yet recorded (42·4 per cent.) occurred at Owena in August 1946, but since host populations also reached a peak at the same time, it is concluded that the parasite is not of great value in control. Hyperparasitism at Owena between September 1945 and October 1946 varied between 3·8 per cent. in the former month and 38·3 per cent. in the latter. An ant of the genus *Macromischoides* is stated in the first report to be frequent on individual undamaged cacao trees in heavily attacked areas in the Gold Coast, but did not appear to prey on the Mirids in the laboratory. As, however, it possibly controls them in nature, experiments on its colonisation in cacao fields, were planned. In the second report, it is stated that this ant is *M. aculeatus*, Mayr, and that its nests, which occur on the lower surface of the leaves of many trees and shrubs, are colonial, so that it is important to transfer the one containing the queen if the ant is used for Mirid control. Attempts at the direct transfer of over 50 incipient colonies, each containing a queen, made in April–May 1946 were unsuccessful, chiefly owing to attack by other ants. Cacao trees that had once harboured and later lost the ant were severely damaged by Mirids.

Work on the control of the Mirids by means of insecticides described in the second report showed that an emulsified solution of DDT in kerosene diluted to the minimum at which DDT is effective was harmful to the leaves and young stems of cacao. A concentration of 0·1 per cent. was the minimum at which nicotine sulphate was effective against both *Sahlbergella* and *Distantiella*. Further work with DDT is described in the third report. Preliminary tests had shown that 1 per cent. DDT as an emulsified solution in vegetable oil

killed both species and remained toxic for 15 days. Since spraying the whole tree results in a costly wastage of spray, the value of applying higher concentrations only to the woody tissue attacked by the Mirids was investigated. In preliminary tests, 2·5 per cent. DDT in emulsified xylene caused slight browning on the flush stems and young flush leaves, but did not damage the older tissues ; a saturated solution of DDT in petrol, 5 per cent. DDT in kerosene, and DDT in vegetable oils all damaged the plants, and the adhesive properties of DDT pastes in talc or lime were poor. The average periods of survival in days of fifth-instar nymphs of *D. theobroma* caged on plants painted with the 2·5 per cent. emulsion and (in brackets) on control plants, 7, 12, 18 and 24 weeks after treatment were 1·9 (3·5), 4 (5), 4·3 (6·6) and 3·6 (8·3), respectively. In a small-scale field test, seedling trees on six plots were treated by painting the emulsion over most of the woody tissues or on those at the branch unions or forks, where the older nymphs shelter during the heat of the day, and six plots of equal size were left as controls. The numbers of nymphs observed during a period of 20 weeks and at the end of it were only 11 and 16 per cent. of the totals observed on all 12 plots. The younger nymphs were able to shelter under leaf petioles at the tips of the twigs of the trees that had been partially painted, however, and caused damage that resulted in considerable die-back at the tips.

It is stated in the second report that the progeny of a Nigerian cacao selection was resistant to Mirids at Tafo, but was severely attacked and showed symptoms of fungous infection at Owena, where, however, Mirids could be reared on it only with difficulty. The results of tests on the relative susceptibility to adults of *S. singularis* of a supposedly resistant clone [**35** 87], given in the third report, indicated that under the conditions of the experiment it was neither tolerant nor resistant.

Doncaster (J. P.) & Gregory (P. H.). **The Spread of Virus Diseases in the Potato Crop.**—*Agric. Res. Coun. Rep.* no. 7, viii+189 pp., 38 figs. (1 fldg.), 53 refs. London, H.M.S.O., 1948. Price 5*s*.

The following is taken from the authors' summary. The rapid degeneration of potatoes brought from seed-growing districts to the English lowlands is due to the spread through the stock of the Aphid-transmitted virus diseases, rugose mosaic and leaf-roll. This study of the epidemiology of these diseases is based on counts of Aphid populations in the field and on records of the spread of the diseases in potato crops in the east of England during 1940–45, supplemented by data obtained in other parts of England and Wales. The maincrop variety Majestic was used in most of the work.

Periodical sampling of 63 crops of Majestic showed that on the average three-quarters of the full yield of tubers was obtained by the middle of August, but in the wetter seasons of 1941 and 1944, about a quarter of it was added in September. The weight of "seed" size tubers averaged 4·1 tons per acre at its maximum in July or August and declined to 3·2 tons at the end of the season. In the variety Majestic, the tubers are formed during July and subsequent differences in individual rate of growth leads to their differentiation into "ware", "seed", and "chats" by the end of the season. The final yield per acre of seed tubers can be increased by close spacing and by planting large setts, but under present conditions in the ware-producing districts, it is more profitable to allow a crop to mature at normal spacing than to attempt by early lifting to control virus or by close spacing to increase the proportion of seed.

The four Aphids that occur regularly on potato crops are *Myzus persicae*, Sulz., *Aphis rhamni*, Boy., *Macrosiphum solanifolii*, Ashm., and *M.* (*Aulacorthum*) *solani*, Kalt. Fruiting peaches out of doors and in unheated glasshouses were

the most important plants on which *Myzus persicae* overwintered in the egg stage. In some seasons it can persist throughout the year on cruciferous crops, but its survival on these plants was greatly reduced in south-east England in the severe winters of 1940–41, 1941–42 and 1944–45. After these winters, its numbers on peach were small and it developed late, and infestations on potatoes were also relatively late in developing. Overwintering on sugar-beet seed crops was also recorded. *Aphis rhamni* apparently overwinters only in the egg stage on *Rhamnus*, but heavy infestations sometimes developed on potatoes in the Lincolnshire fens, where this plant is rare.

The spring migration of *M. persicae* from peach or crucifers to potatoes took place each year during May and sometimes continued into June, when early potatoes are well advanced and maincrop varieties just above ground. The maximum population on the foliage was usually reached towards the end of July. Numbers then declined, owing to migration to other food-plants and the activities of parasites and predators, and reached a minimum during the first half of August ; they sometimes showed a second, but smaller, rise in September. In 1941, the population did not reach its maximum until about the end of August, and this was associated with unusually late spread of leaf-roll in potato crops. In 1942, populations of *M. persicae* were very small.

The spring migrants of *A. rhamni* reach the potato crop in June or early July, and peak infestations occur in August. Populations on potato were high in 1940 and 1941, and very high in 1942, when *M. persicae* was scarce. *A. rhamni* was almost absent from potatoes in 1943–45.

Populations of *Macrosiphum solanifolii* and *M. solani* followed approximately the same course as those of *Myzus persicae*, but heavy infestations occurred on potatoes only in 1945. There is no evidence that either of these two species plays any appreciable part in transmitting rugose mosaic or leaf-roll in the field.

On the whole, both diseases spread most in fields with large numbers of *M. persicae*, but wide discrepancies were found, indicating that factors other than the presence of large populations of apterae on the plants or flights by dispersal migrants as shown by trap records, must play a part in determining the amount of virus transmission. There is evidence that much spread is effected by winged spring migrants. Apterae may also play a part at or near the peak of the infestation, especially where interlacing foliage facilitates movement from one plant to another. The winged dispersal migrants of *M. persicae* in summer are believed to be of relatively little importance.

Periodical sampling on a standard plan gave information on the season and extent of spread of the diseases at a number of centres in different years. In recognised seed-growing districts, such as North Wales, Dartmoor and Northumberland, there was very little increase in diseases, but the amount of spread in lowland districts varied greatly. It was generally slight in 1942, when *M. persicae* was scarce on all food-plants. In lowland districts, the increase of rugose mosaic on a standard plot varied from one quarter to nearly six times that of leaf-roll. Most infection occurred early in the season, and only about 10 per cent. of the crops sampled showed a substantial increase of rugose mosaic after the first week in August, whereas the figure for leaf-roll was 30 per cent. Burning the haulms or lifting early enough to avoid virus infection of the tubers would involve a substantial loss of ware.

The probability of a plant becoming infected is greatest when it is next to an infected plant and generally decreases rapidly at increasing distances from an isolated infected plant and less rapidly from a strip or an area of diseased plants. In healthy crops adjoining diseased ones, a gradient of infection cannot usually be detected at distances greater than about 10–20 rows from the diseased plants. The amount of infection from sources more distant than an adjoining crop is usually slight in comparison with the spread from diseased plants present in the field. Removing secondarily diseased plants from Majestic

stocks during July usually did not appreciably reduce the spread of either disease. Roguing in mid-June, tried in one season only, reduced rugose mosaic to one-third of the amount in unrogued plots, but had no effect on the spread of leaf-roll. The failure of roguing is presumably due to the early date at which virus transmission takes place. It is estimated that if plants showing primary symptoms of virus infection were also removed during repeated roguing, the percentage of diseased tubers would be halved, and that further improvement would result if the two plants adjacent to each infector were also removed as a routine measure.

The effect of fumigating large plots with nicotine vapour was studied in 1942–44. A single treatment early in July was usually successful in destroying the Aphids, but had little effect on the spread of the virus diseases, presumably because of transmission before July by spring migrants.

In 1944–46, the survival of self-set potatoes on English arable fields averaged 2,000–7,000 per acre in the first crop after potatoes and fell to 500–800 per acre in the third. Three years was the average interval between potato crops in the fields studied. Rugose mosaic and leaf-roll do not usually increase in self-set plants, and those from a stock planted with healthy seed are not as a rule an important factor in the degeneration of potato stocks, but those from diseased stocks can cause an abnormally large increase in virus disease.

Reasonably good seed could probably be produced in the English lowlands during an emergency by drastic roguing and early lifting, but this would normally be uneconomic. The most practical method of increasing the life of seed stocks appears to be to improve still further the health of stocks raised in seed-growing districts, to grow them in relative isolation and, most important of all, to plant them on land free from self-set potatoes.

Post (R. L.), Munro (J. A.) & Knapp (R. B.). **Chemical Control of Wireworms.** —*Bi-m. Bull. N. Dak. agric. Exp. Sta.* **10** no. 1 pp. 26–31, 2 figs., 8 refs. Fargo, N. Dak., 1947.

Reports by D. E. Greenwood in Connecticut and B. P. Pepper and others in New Jersey of the effectiveness of BHC (benzene hexachloride) against wireworms were confirmed by an experiment in North Dakota in 1947 against *Corymbites* (*Ludius*) *aeripennis destructor*, Brown, which is the prevalent species in that State [*cf. R.A.E.*, A **31** 210]. Two fields of wheat were selected, in both of which the wireworms, most of them small, had attacked the germinating grain so heavily that the crop was very thin or entirely destroyed in the areas of infestation. Dusts of 5 per cent. DDT, 5 per cent. chlordane and 10 per cent. BHC (giving about 1 per cent. γ isomer) were applied on 12th–14th June at 20 lb. per acre and the plots were disked or harrowed to a depth of about 5 ins. on the same day. The total numbers of wireworms recovered from equal samples of soil taken at random from the treated plots in early September were 61 for DDT, 45 for chlordane, 9 for BHC and 62 for no treatment in the first field and 79, 62 and 2 for the three insecticides, respectively, in the second.

It is concluded that damage to potato and wheat in wireworm-infested fields can be prevented by treatment with BHC, which should be worked into the soil with a disk or harrow within 24 hours of treatment. The application should be made at least a month before sowing or planting a susceptible crop. It has been suggested that BHC may taint potatoes grown in treated soil, but Greenwood found that tubers had no odour when grown in soil treated with 2·5 lb. per acre, and Pepper reported that when tubers from treated soil were cooked and sampled by 23 persons, more than 50 per cent. of these rated one or more of the treated samples as tasting better than the controls and five had no preference.

Cook (W. C.). **The Relation of Spring Movements of the Beet Leafhopper (*Eutettix tenellus* Baker) in Central California to Temperature Accumulations (Homoptera).**—*Ann. ent. Soc. Amer.* **38** no. 2 pp. 149–162, 4 figs., 6 refs. Columbus, Ohio, 1945.

During April and May, *Eutettix tenellus*, Baker, migrates from the semi-desert plains and foothills bordering the western and south-western parts of the San Joaquin Valley of California into the cultivated districts of the valley, where it transmits curly top disease [*Chlorogenus eutetticola* of Holmes] to sugar-beet, garden beets, tomatos and melon. Resistant varieties of garden beets, tomatos and melons are not available, and direct control of the leafhopper after it reaches these crops has not proved feasible, but damage can be reduced by timing their planting so that they are not present at the time of the spring migration. As there is considerable variation in the time of the spring movements of the insects, attempts were made to develop a method of estimating when they would probably occur.

Spring temperatures are higher in the south of the valley than in the north, and dispersals of the leafhopper from the southern areas usually precede those from the more northern ones, indicating that the movements are related to a definite accumulation of temperature, which may be necessary to mature the spring adults and prepare them for movement. It is the author's object to show that such a temperature accumulation exists and that it is of value in estimating the times of movement. He assumes that movements of *E. tenellus* are closely related to the time of brood maturity, that there is a linear relationship between temperature and the rate of development of the eggs and nymphs, that shade temperature is an index of the temperature under a sparse cover of vegetation on warm slopes in the sun, and that the average of readings of maximum and minimum thermometers gives the mean temperature for each day; he shows that although these assumptions are not strictly accurate, any variations from them are unimportant for his purposes.

It has been found that the theoretical threshold of development for *E. tenellus* is 57·5°F., but the shade temperatures used for this study are not the actual temperatures to which it is exposed. Field observations during winter and spring showed that overwintering females are very active at an air temperature of about 50°F. and completely inactive at about 40°, the lowest temperature at which activity was consistently observed being about 45°, and that in this district a shade temperature of about 45° corresponds to a soil temperature of 58°. Effective temperatures are therefore considered to be those above 45°F. The females of the autumn generation oviposit early in the following year, and the rate of development of the ovaries seems to depend on food as well as temperature, being possibly influenced by length of time between the maturing of adults of the autumn generation and the germination of succulent winter annuals, so that the basal date for summing temperatures should be between 15th October, when the majority of the adults mature, and 1st February, when they are ovipositing. A long preliminary study was made in which various dates, such as those of autumn movements, germination of winter annuals and of first oviposition were tried as bases from which to sum temperatures, the criterion being the constancy of the temperature sum over a period of 20 years, and the date selected was 1st January. For some time about this date there is very little accumulation of effective temperature, it is close to the beginning of the oviposition period, and experimental and field studies of vitality and fat reserves indicated that the physiological condition of the overwintering females is about the same each year in January, regardless of autumn conditions.

The dates of observed spring migrations of *E. tenellus* were recorded in the years 1919–35. It is assumed that in years in which three were recorded these

were in the south, centre and north of the valley, and the temperature accumulations, in day-degrees above 45°F. from 1st January were calculated for the first and second from the daily mean temperatures at the local weather stations. There was a wide range between the temperature sums in different years, owing to the unreliability of the original data, but the average temperature sums in the two districts differed by 19 day-degrees, which can be accounted for by a single day's difference in the date of migration. The average of the temperature sums at the two stations was 823·3 day-degrees, and a sum of 825 day-degrees was chosen as a round number for computation. The dates of observed movements in 1936–40 were used to test the accuracy of this and it was found that migration occurred on the calculated date in one instance, after it in 17 and before it in four. Migration after the calculated date may be due to delay caused by unfavourable weather conditions after the maturity of the leafhoppers, and migration before it to movements of small numbers caused by favourable conditions before the development of the majority. The average deviation between observed and calculated dates of movement was about 3–4 days, which is considered satisfactory agreement.

It is doubtful whether the same temperature sum would be valid in other parts of the range of *E. tenellus*, because the relations between soil temperature and shade temperature vary with latitude, altitude and the amount of sunshine. Also, the magnitude of the temperature sum required may depend on slope, exposure and latitude, all of which affect the amount of heat received per unit area, and the food-plants on which the nymphs are reared. It appears, however, that migration is closely correlated with the accumulation of a definite amount of heat, and similar summations might be made for other regions within the range of the leafhopper.

Bissell (T. L.). *Myiophasia globosa* (**Tns.**), **Tachinid Parasite of the Cowpea Curculio.**—*Ann. ent. Soc. Amer.* **38** no. 3 pp. 417–440, 27 figs., 27 refs. Columbus, Ohio, 1945.

Chalcodermus aeneus, Boh., is an important pest of cowpeas in the pod in the southern United States, particularly in the early part of the bearing season. In Georgia, the Tachinid, *Myiophasia globosa*, Tns., is the most important of a number of parasites that attack the larvae and has been common in some localities every year since 1936, when investigations on the weevil were begun. It has also been recorded in the United States parasitising *Anthonomus grandis*, Boh., on cotton, *Conotrachelus nenuphar*, Hbst., on peach and several other less familiar weevils.

Detailed investigations on the parasite were made in 1940–43. Infested cowpeas were picked at intervals through the bearing season and kept until all the grubs had issued. These were collected daily and some were allowed to burrow into soil in glass jars, the adults and parasites being counted as they emerged. Others were put in individual cells in a cage of plaster of paris, unparasitised grubs being discarded as they pupated and those with parasites left in the cells for observation ; when the parasites pupated they were put in stoppered vials for the emergence of the adults. For anatomical studies and photographs, parasitised grubs were cleared in a mixture of phenol and chloral hydrate and mounted or preserved in alcohol.

Detailed descriptions are given of the three larval instars, the puparium, prepupa, pupa and adults and of the life-history of the parasite [*cf. R.A.E.*, A **32** 332]. The parasite larvae are deposited on the food-plant and rapidly crawl into the punctures in which the weevils have laid their eggs if the seals are imperfect. They usually enter their hosts as soon as the latter hatch but occasionally do so later. The parasites burrow into the hosts rapidly but remain comparatively inactive and do not grow much during the feeding period

of the latter. They may be in any part of the body when the host larva leaves the pod to enter the soil, but a day or two later they usually move to the metathorax, where they puncture the host skin and extrude the cauda and spiracles to breathe. The parasite moults within a day after fixing itself and again about a day and a half later. It pupates within the host skin, and parasitised larvae die without pupating. Male and female parasites occurred in about equal numbers. They fed in the laboratory on invert sugar and water and in one case on the juice from a weevil puncture on a green pod, and in the field were observed feeding on the nectaries on the cowpea fruiting stem. In the plaster cells, the parasite larvae appeared in the metathorax of the hosts 1–12 days and moulted 1–13 days after the latter left the cowpeas, and the second and third instars and pupal stage averaged 1·3, 2·5 and 10·1 days and development outside the pods 17·6 days. In soil in cages, the average developmental periods were 19·3, 19·8 and 29·4 days in July, August and September, respectively. The mean period of total development from larviposition to emergence of adult is estimated at about 32 days (12 days in the pod and 20 outside). Some abnormalities in life-history are discussed. More than one parasite sometimes enter a single weevil, but only one matures. Of 167 parasitised grubs examined, 45 per cent. had more than one parasite (either larva or puparium), the largest number in one host being 24. Although *M. globosa* rarely developed in the larva of *C. aeneus* in the cowpea pod, a puparium with a practically mature fly was found in a dead larva of *Bruchus* (*Callosobruchus*) *maculatus*, F., in a dried pod that had been picked on 20th July.

The adult parasites are active during the oviposition period of *C. aeneus*, which extends from the beginning of July to the beginning of October in Georgia. The earliest collection of flies in any year was made on 2nd July, in 1942, and cowpeas picked on that day had parasitised grubs from which flies of the new generation emerged between 21st and 31st July. Flies continued to emerge throughout August and September, showing that activity in the field is more or less continuous. The latest pods from which adult flies were obtained were picked on 14th September, although cowpeas picked in October had grubs with parasite larvae that did not mature. The last flies emerged in cages on 26th October. Extensive search for hibernating parasites in the soil of cowpea fields was unsuccessful, but in one year five larvae of the weevil, four containing parasites, were found between 13th and 20th November, which suggests that the winter may be passed in this manner. Puparia were never found in winter. Of 15,190 weevil larvae that left the pods to pupate, 13·1 per cent. were parasitised by *M. globosa*. There was a decided reduction in parasitism as well as in weevil activity in the latter part of the season. A few of the grubs that burrowed into the soil were parasitised by the Braconid, *Triaspis curculionis* var. *rufus*, Ril., and many were killed by a fungus or died, apparently from weakness.

String beans are infested by *C. aeneus* to a minor degree, and of 176 larvae collected from beans in Georgia in four years, two were parasitised by *M. globosa*. Cotton squares punctured by *A. grandis* were collected by Federal workers in various States at intervals in 1935 and 1936; the Tachinid was reared from a small percentage of those collected in Louisiana, Mississippi, Georgia, Florida and the Carolines but not from Tennessee or Virginia [but *cf.* **35** 405]. Although well distributed, the parasite is very unimportant in controlling *A. grandis*.

Bess (H. A.). **A Measure of the Influence of natural Mortality Factors on Insect Survival.**—*Ann. ent. Soc. Amer.* **38** no. 4 pp. 472–481, 4 refs. Columbus, Ohio, 1945.

The following is substantially the author's summary. Percentages of mortality as such are inadequate for appraising and comparing mortality factors as agents

in the control of insects. Ratios of mortality to survival may be useful measures of the relative effects of control agents in the reduction of insect populations and these ratios, as determined for one or more factors which produce mortality in two or more stages in the development of an insect, can readily be combined to procure an estimate of the total effect produced by the factor or factors. Thus, if the ratios of dead to living caused by factors that affect the eggs and larvae, respectively, are A and B, the ratio caused by both factors will be A+B+AB. In a study to determine the relative effects of different mortality factors in the regulation of insect populations over a series of generations or years, the population density should be determined as frequently as practical. Estimates of the proportion of the population killed or affected by a particular factor are often obtained without procuring an estimate of the population density. Ratios of mortality to survival derived from estimates of the proportion of the population killed may indicate the relative effects of different factors in the reduction of the abundance of an insect in a single generation, even though no estimates are obtained of the population of the insect when the factor or factors operated. It is shown that, even though the interaction of mortality factors complicates the problem of appraising and comparing different factors as reduction agents, estimates of their relative reduction effects can be procured.

Papers noticed by Title only.

Park (T.) & Davis (M. B.). **Further Analysis of Fecundity in the Flour Beetles** *Tribolium confusum* **Duval and** *Tribolium castaneum* **Herbst.**—*Ann. ent. Soc. Amer.* **38** no. 2 pp. 237–244, 3 graphs, 6 refs. Columbus, Ohio, 1945. [For Abstract see *R.A.E.*, A **32** 389.]

Yeager (J. F.) & Munson (S. C.). **The Relation between Poison Concentration and Survival Time of Roaches** [*Periplaneta americana*, L., and *Blatta orientalis*, L.] **injected with Sodium Metarsenite.**—*Ann. ent. Soc. Amer.* **38** no. 4 pp. 559–600, 5 figs., 15 refs. Columbus, Ohio, 1945. [*Cf. R.A.E.*, A **33** 64.]

Grove (J. F.) & Bovingdon (H. H. S.). **Thiocyanate Insecticides : the Relation between knock-down Activity and chemical Constitution** [of thiocyanoacetates and thiocyanoketones].—*Ann. appl. Biol.* **34** no. 1 pp. 113–126, 32 refs. London, 1947. [See *R.A.E.*, B **37** 49.]

Zimmerman (E. C.). **Browne 1887, not Douglas 1888, the Author of** *Orthezia insignis* **(Homoptera : Coccoidea).**—*Proc. Hawaii. ent. Soc.* **12** no. 3 pp. 657–658. Honolulu, 1946.

Vappula (N. A.). **Finnish Entomological Literature published in 1946 including** [titles of papers on] **Economic Entomology and Control of Insect Pests.**—*Ann. ent. fenn.* **14** appx. 14 pp. Helsinki, 1948. [*Cf. R.A.E.*, A **35** 232.]

Report of the Fifth COMMONWEALTH ENTOMOLOGICAL CONFERENCE,

22nd-30th JULY, 1948.

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A memorandum of the work of the Institute from 1935 to 1948 is given in Appendix I (pp. 14–19). The reports of the various Committees constitute Appendix II (pp. 20–26). Appendix III (pp. 27–112) consists of the proceedings of the scientific meetings, which are as follows :

Subjects	*Openers*
Recent Developments in Insecticides	R. A. E. Galley
Mode of Action of new Insecticides	V. B. Wigglesworth
Uses and Limitations of the new Insecticides in the Field	W. A. Ross
Recent Developments in Pest and Disease Control Machinery	H. G. H. Kearns G. H. Berkeley
Application of Insecticides from the Air ...	D. L. Gunn
Biological Control	A. B. Baird W. Cottier R. H. Le Pelley D. Miller
Estimation of Insect Populations in the Field	A. H. Strickland
Developments in the Control of Stored Products Insects	F. N. Ratcliffe
Tsetse Research and Control	T. A. M. Nash K. R. S. Morris
The Need for Plant Quarantine on a Continental Basis, with special Reference to Africa ...	G. F. Clay
History of the Bureau of Biological Control ...	Sir H. Howard
Locusts and Grasshoppers	B. P. Uvarov A. J. Nicholson
Discussion of Summary of Information on Termites	

The papers read by the openers are given in full, together with summaries of the discussions that ensued.

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AGRICULTURAL CHEMICALS (NEW YORK, N.Y.) : Vol. 1 (1946) Nos. 1–5.
AGRICULTURAL JOURNAL, DEPARTMENT OF AGRICULTURE, BRITISH COLUMBIA (VICTORIA) : Vol. 1 (1916) Nos. 1–2.
AGRICULTURAL NEWS (BARBADOS) : Nos. 1, 25, 26, 34, 66 (1902–04).
AGRICULTURE AND ANIMAL HUSBANDRY IN INDIA (DELHI) : 1937–38 & 1938–39.
AMERICAN JOURNAL OF VETERINARY RESEARCH (CHICAGO, ILL.) : Vols. 1 & 2 (1940–41) Nos. 1–5.
ANALELE INSTITUTULUI DE CERCETĂRI AGRONOMICE AL ROMÂNIEI (BUCHAREST) : Tome 14 (1942).
ANALES DE LA SOCIEDAD CIENTÍFICA ARGENTINA (BUENOS AIRES) : Vol. 98 (1924) Nos. 5–6.
ANNALS OF THE QUEENSLAND MUSEUM (BRISBANE) : No. 5.
ARBEITEN DER BIOLOGISCHEN STATION ZU KOSSINO (MOSCOW) : Lief. 1 (?1925).
ARCHIVES DE L'INSTITUT PASTEUR DE TUNIS : 1906–09 ; 1910 fasc. 1–3 ; 1911 fasc. 3–4.
ARCHIVES DU MUSÉE ZOOLOGIQUE DE L'UNIVERSITÉ DE MOSCOU : Vol. 5 (?1938).
ARIZONA COMMISSION OF AGRICULTURE AND HORTICULTURE (PHOENIX, ARIZ.) : 1st–10th Annual Reports ; Circulars 15–16 (1909–18).
ARQUIVOS DO INSTITUTO BACTERIOLÓGICO CÂMARA PESTANA (LISBON) : Vol. 1 (1906).
THE BEE WORLD (BENSON, OXON.) : Vols. 1–2 (1919–21).
BERICHT ÜBER DIE WISSENSCHAFTLICHEN LEISTUNGEN IM GEBIETE DER ENTOMOLOGIE während des Jahres 1914 (BERLIN) : Nos. 1 & 5.
BIOLOGICAL BULLETIN OF THE MARINE BIOLOGICAL LABORATORY (WOODS HOLE, MASS.) : Vols. 1–2 (1899–1901) ; 23 (1912) ; 24 (1912) No. 2 ; 25 (1913) Nos. 5–6 ; 26 (1914) Nos. 1–2 ; 27 (1914) No. 4 ; 28 (1915) No. 1 ; 29 (1915) No. 5 ; 30 (1916) Nos. 2–3 ; 31 (1916) Nos. 4 & 6 ; 32–33 (1917) ; 34 (1918) Nos. 1–4 & 6 ; 35 (1918) ; 36 (1919) Nos. 2–3 ; 37 (1919) Nos. 4 & 6 ; 38 (1920) Nos. 1, 2, 5 & 6 ; 39 (1920) Nos. 4–6 ; 40 (1921) Nos. 1–4 & 6 ; 41 (1921) Nos. 2–3 ; 42 (1922) Nos. 1–3.
BOLETÍN DE LA DIRECCIÓN DE ESTUDIOS BIOLÓGICOS (MEXICO) : Tomos 1–2 (1924–25).
BOLETÍN DE LA OFICINA SANITARIA PANAMERICANA (WASHINGTON, D.C.) : Vol. 22 (1943) No. 11.
BOLLETTINO DELLA SOCIETÀ ITALIANA DI BIOLOGIA SPERIMENTALE (NAPLES) : Vols. 17 (1942) Nos. 5–6 ; 18–21 (1943–45).
BULLETIN AGRICOLE DE L'ALGÉRIE-TUNISIE-MAROC (ALGIERS) : Année 20 (1914) Nos. 7–9, 12–14.
BULLETIN DU COMITÉ D'ÉTUDES HISTORIQUES ET SCIENTIFIQUES DE L'AFRIQUE OCCIDENTALE FRANÇAISE (PARIS) : Année 1919 No. 1.
BULLETIN DE L'INSTITUT DES RECHERCHES BIOLOGIQUES (PERM) : Tome 1 (1923) fasc. 1–2.
BULLETIN DE LA STATION RÉGIONALE PROTECTRICE DES PLANTES À LENINGRAD : Vol. 6 (?1927) ; 7 (1936) No. 2.
BULLETIN OF THE STONEHAM MUSEUM (KITALE) : Nos. 37, 41.
CARIBBEAN FORESTER (NEW ORLEANS, LA.) : Vol. 1 (1940) No. 1.
CHACARAS E QUINTAES (SÃO PAULO) : Indices to vols. 10, 11, 12, 14 ; vol. 42 (1930) No. 3.
CHOROBY ROŚLIN (WARSAW) : T.1 cz. 1 (1931).
COMPTES RENDUS DES SÉANCES DE L'ACADÉMIE D'AGRICULTURE DE FRANCE (PARIS) : Tome 8 (1922) No. 5.
COMPTES RENDUS DE L'ACADÉMIE DES SCIENCES DE L'URSS (MOSCOW) : (N.S.) Vols. 26 (1940) Nos. 8–9 ; 27 (1940) ; 28 (1940) No. 1 ; 33 (1941) Nos. 4–6 ; 41 (1943) Nos. 8–9 ; 44 (1944) Nos. 4–9 ; 45 (1944) No. 1 ; 48 (1945) Nos. 4–5, 8–9 ; 54 (1946) No. 9 ; 55 (1947) No. 7 ; 56 (1947) No. 2.
CYPRUS AGRICULTURAL JOURNAL (NICOSIA) : Vol. 23 (1928) Pt. 3.
DOKLADUI AKADEMIÍ NAUK SSSR (MOSCOW) : (N.S.) Vols. 57–58 (1947) ; 59 (1948) Nos. 8–9 ; 60 (1948) Nos. 1–3.
EAST AFRICAN AGRICULTURAL JOURNAL (NAIROBI) : Vol. 5 (1940) No. 4.
EAST AFRICAN MEDICAL JOURNAL (NAIROBI) : Vol. 22 (1945) No. 7.
EGATEA, REVISTA DA ESCOLA DE ENGENHARIA DE PORTO ALEGRE, BRAZIL (PORTO ALEGRE) : Vols. 1–6 (1916–21) ; 7 (1922) Nos. 1–5 ; 8 (1923) Nos. 2–5 ; 9 (1924) Nos. 1, 4–6.
EGYPT. MINISTRY OF AGRICULTURE (CAIRO) : Bulletins 158, 162, 170–172, 174, 204, 212, 215, 227 (1938), 228, 230, 232, 235.
ENTOMOLOGISCHE LITTERATURBLÄTTER (BERLIN) : 6 Jahrg. (1906) Nos. 2 & 10.
EXPERIMENT STATION RECORD (WASHINGTON, D.C.) : Vols. 1–4 (1889–94).

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CONTENTS.

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